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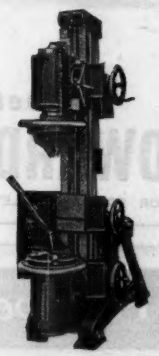

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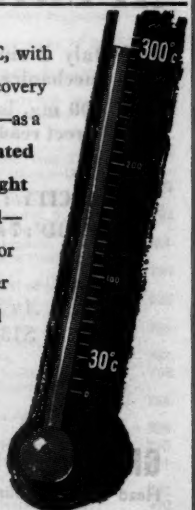

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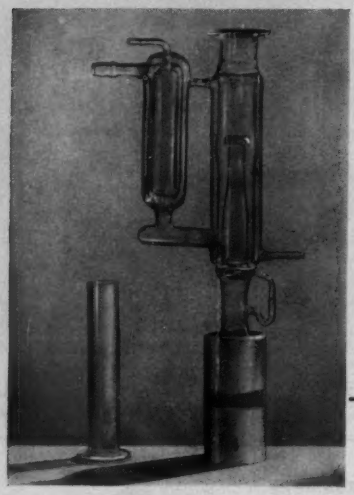

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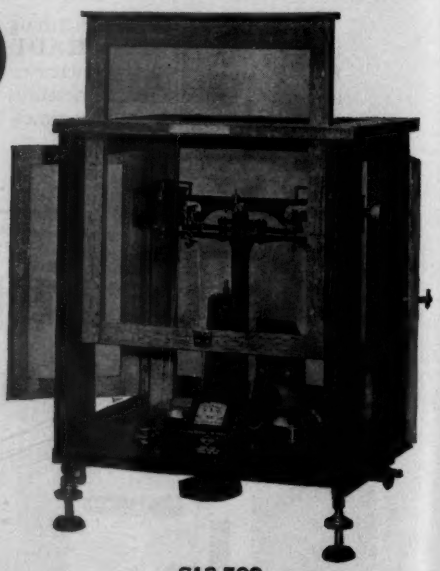

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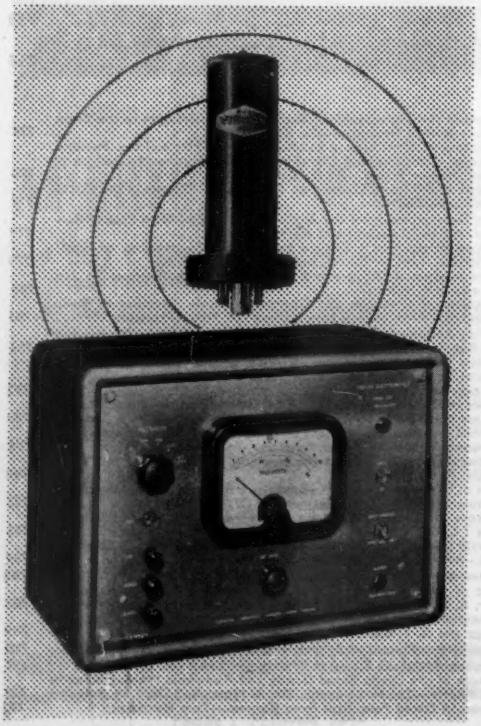

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THE COMPTROLLERSHIP OF THE PATENT OFFICE

"THAT a scientific office should have a scientific man at its head is a principle which seems obvious but needs to be constantly reasserted, because the administrative officials who influence such appointments are not always sympathetic towards the claims of science." These words are quoted from an editorial published in *Nature* thirty-three years ago, on February 27, 1925. It had become known that the Comptroller-General of the Patent Office was likely to retire and that an administrative officer, without legal or scientific qualifications, had been chosen to fill the vacancy when this should occur.

To-day the importance of applying scientific methods and results to public affairs is so generally accepted in industry and in many other fields that it has become a truism. Nobody would expect Imperial Chemical Industries, or the Atomic Energy Research Establishment at Harwell, or the National Physical Laboratory, to be under the direction of a man who had never worked in a laboratory. But fifty years ago the role of the scientist in administration was merely to supply information or advice to non-scientific administrators, who might or might not be capable of understanding it, and who certainly were ill-qualified to evaluate its significance in relation to policy. Even as late as 1925, however, it was necessary to refer, in the article quoted above, to a "tendency to regard a man of science as a mere adviser who is himself incapable of administrative work. Such an attitude is the more unjustifiable because of the fact that a scientific training is necessarily additional to some degree of education in the humanities, whereas a literary scholar may be quite ignorant of science; so that the former type of upbringing is the more likely to produce the breadth of outlook which is necessary in handling men and affairs". It was to further this point of view that the British Science Guild had been founded, and largely through its work the importance of according the scientist his proper place was acknowledged. Eventually, the British Science Guild, with its assets and functions, was absorbed into the British Association, and the latter began to pay increased attention to the social aspects of science.

But in 1925 the battle had not been won, and a deputation from the British Science Guild, led by Sir Richard Gregory, and including such men as Marconi, Sir Hugo Hirst and the first Lord Melchett, visited the President of the Board of Trade. The daily Press joined in, and after a strenuous battle common sense eventually triumphed. From that date until the beginning of this month, the Comptrollers of the Patent Office have been scientists with legal training and long experience of the intricacies of patent practice.

Meanwhile, the average invention has become immeasurably more technical than before, the rate of filing of complete specifications has increased by half, international negotiations relating to industrial property have become more intricate, the Second World War has left behind a number of problems demanding first-hand knowledge for their solution, and the competition of industry for the services of scientists has increased the need for handling the examining staff with understanding if they are not to be tempted to seek employment elsewhere. Yet successive Comptrollers have contrived to maintain, in the teeth of the most harassing difficulties, the services which the Patent Office renders to industry.

The qualifications needed by the Comptroller of the Patent Office arise partly from the fact that he has to handle a staff which is predominantly scientific and technical, and partly from the nature of the statutory duties laid upon him by the Patents Acts. As regard the first point, "it would be unreasonable", to quote once more from the editorial referred to above, "to subordinate the Examining Staff to the control of a man who is not qualified, by a scientific training similar to theirs, to understand the outlook and mentality with which such a training is associated". That is even more true to-day, for the staff must be able to feel full confidence in its leader if it is to carry out with the necessary zest the gruelling task which it is particularly engaged upon at the present time, namely, that of reducing the long delay in the granting of patents without reducing the quality of the examination, with a consequent increase in litigation.

As regards the Comptroller's statutory duties: his court is a court of first instance for certain classes of patent litigation, and though he delegates some of this work to his immediate subordinates on the examining staff, it has been usual (except in certain instances where bad health intervened) for him to take the most important hearings in person, and in any event to guide his staff on legal points. Comptrollers have also attended international conferences on industrial property in person, and acted as chairman in at least one instance. It is important that they should do so, and that they should be able to deal with the representatives of other countries on a footing of equality in the range of knowledge which comes from a scientific and legal background, with a foreground of experience of the highly specialized subject-matter with which such conferences have to deal.

For the past two years, negotiations have been in progress in relation to patents within the European Free-Trade Area, and they are now entering upon an acute stage. British interests are likely to be at a disadvantage if Germany succeeds in her strenuous efforts to have the Patent Office of the Area established under her tutelage.

We have just stated that the Comptrollers of the Patent Office have had the requisite professional qualifications "until the beginning of this month". It is no secret that the Board of Trade has been

faced with a difficult establishment problem in that it has a redundancy of senior administrative officers for whom it has to find suitable posts. Such a post has been provided by the retirement through ill-health of the Comptroller-General of the Patent Office, which by historical accident is a department of the Board of Trade, and an appointment has been made; this has been done by way of surprise, before the action taken in 1925 could be repeated. *Nature* is, of course, in no way concerned with personal considerations; but it is concerned when a vitally important principle, for which it has always fought and which has come to be generally accepted in industry and in government departments of modern origin, has been violated by means of a *fait accompli*. To ask that what has been done should now be undone is to ask a great deal; but, on the other hand, a great deal is owed to the nation by way of reparation by a government department which has acted in such a way at a time when technological progress has become a matter of the utmost urgency in relation to the national interest.

The head of the Patent Office, if he be not a scientist and a lawyer with long experience of patent practice, cannot be more than a figure-head for subordinates who do possess those qualifications, and a figure-head cannot hope to discharge the duties of the office in a way which will give satisfaction. The Patent Office is a vitally important feature of the industrial world, and of international significance particularly at the present time. The appointment of a mere figure-head cannot but do disservice to the national interest.

IONOSPHERIC RESEARCH

Annals of the International Geophysical Year

Vol. 3, Part 1. Pp. xix+168. Vol. 3, Parts 2, 3 and 4. Pp. 169–381. Subscription per volume: 120*s.*; 17 dollars. (London and New York: Pergamon Press, 1957.)

AT this stage in the progress of the International Geophysical Year, which covers the period July 1, 1957, to December 31, 1958, the detailed programmes of observations are well in hand in all parts of the world. The results of these observations are being collected in an internationally agreed form at a number of world data centres, so that they may be available for scientific workers everywhere. Various discussions of these results and their analysis will undoubtedly occur from time to time in the course of normal scientific publications. In order to ensure that a co-ordinated central record of the whole proceedings of the International Geophysical Year is available for both present and future readers and students, it was decided, at an early stage in the discussions of the Special International Committee (C.S.A.G.I.), to publish a connected series of Annals of the International Geophysical Year. These are published by the Pergamon Press, Ltd., under the general editorship of Sir Harold Spencer Jones, assisted by an advisory board comprising international experts in the various disciplines involved.

The first two volumes of the series will deal, respectively, with the history of the events leading up to the present International Geophysical Year, and with the proceedings of the Special International Committee and its associate bodies. Vol. 3 is, however, the first to be published since it was produced originally in the form of a series of radio instruction manuals for those engaged in the study of the ionosphere. With the aid of the component sections of this volume, the detailed technique for sounding the ionosphere and presenting the results has been standardized together with the associated terminology. They are, moreover, much more than booklets of instruction and guidance. In its present published form, this volume forms a notable contribution to the somewhat sparse number of available books dealing with the ionosphere and various other radio phenomena, such as atmospherics, associated with the atmosphere.

Vol. 3 is divided into four parts, of which the first, entitled "Ionospheric Vertical Soundings", has been compiled by J. W. Wright and R. W. Knecht (U.S. National Bureau of Standards) and K. Davies (Radio Physics Laboratory, Ottawa), and edited by W. J. G. Beynon and G. M. Brown (University College of Swansea). An introduction covering the programme of the International Geophysical Year is followed by a chapter dealing with ionospheric physics, outlining the main characteristics of the ionosphere which are studied by radio techniques. There follow short descriptions of the fourteen types of ionosondes at present available; and practical instructions are given for adjusting the equipment to obtain the best results. The next chapter, on "Interpretation of Ionograms", provides detailed guidance on the evaluation of the ionospheric parameters from the photographic records, the great variety of which is illustrated by some fifty excellent photographs. Chapter 6, on "Reduction of Ionograms", is equally helpful and well illustrated, and it should prove invaluable to a newcomer to this complicated technique. A short chapter on the assessment of the quality of the data and a very brief list of references are followed by six appendixes which deal with programmes, interchange of data and suggestions for research at stations.

Part 2 deals with "The Measurement of Ionospheric Absorption" and has been compiled by a number of authors with considerable experience in this field: W. R. Piggott (Radio Research Station, Slough), W. J. G. Beynon and G. M. Brown (University College of Swansea) and C. G. Little (Geophysical Institute, College, Alaska). An account is given of the general theory of the absorption of radio-waves in the ionosphere, and of two methods of measurement; namely, the pulse reflexion method using ionosonde technique, and the other, developed particularly by radio-astronomers, using radio-waves of extra-terrestrial origin. As in the preceding part, the subject of nomenclature and presentation of results is dealt with in appendixes.

The third part is entitled "The Measurement of Ionospheric Drifts" and comprises separate contributions by B. H. Briggs (Cambridge), L. G. H. Huxley (Adelaide) and J. S. Greenhow (Manchester). The separate chapters deal with the measurement of ionospheric drift velocities by simultaneous fading records on three receivers, by observations on meteor reflexions, and by some other techniques available to ionospheric physicists and radio astronomers.

The contents of Part 4 conform with its heading, "Miscellaneous Radio Measurements", but some of these are not immediately obvious as coming under the general title of Vol. 3, "The Ionosphere".

Nevertheless, the six contributions form a very appropriate ancillary part of the volume and are certainly directly related to portions of the programme of the International Geophysical Year under active study at the present time. These individual papers are entitled: "The Measurement of Atmospheric Radio Noise", by F. Horner (Radio Research Station, Slough); "Whistlers and Dawn Chorus", by M. G. Morgan (Dartmouth College, Hanover, U.S.A.); "Radio Reflections from Aurorae", by A. C. B. Lovell (Manchester), P. A. Forsyth (Saskatchewan) and L. Harang (Auroral Observatory, Tromsö); "Apparatus for Radio-Echo Meteor Survey", by A. C. B. Lovell; "Ionospheric Forward Scatter", by K. L. Bowles (U.S. National Bureau of Standards); and "Ionospheric Back Scatter", by A. M. Peterson (Stanford University). All these sections form well-illustrated reviews, each with selected references which should prove useful for further study.

The publication of this volume (in two sections) shows that the work of preparation for the International Geophysical Year has successfully stimulated the production of a most useful addition to the scientific literature on the detailed characteristics of the ionosphere and related physical phenomena.

R. L. SMITH-ROSE

ÅNGSTRÖM RADIATION AS PHENOMENON AND AS TOOL

Handbuch der Physik

Herausgegeben von S. Flügge. Band 30: Röntgenstrahlen. Pp. vii+384. Band 32: Strukturforschung. Pp. vii+663. (Berlin: Springer-Verlag, 1957.) 88 and 144 D.M., respectively.

THESE books, though edited, printed and published in Germany, are largely written in English. In Vol. 30 only the first chapter, on the production of X-rays, by W. Schaaffs, is in German. The remaining chapters deal with experimental methods of X-ray spectroscopy at ordinary wave-lengths, by A. E. Sandström; experimental methods of soft X-ray spectroscopy and the valence-band spectra of the light elements, by D. H. Tomboulian; X-ray microscopy, by P. Kirkpatrick and H. H. Pattee; and the continuous X-ray spectrum, by S. T. Stephenson. Vol. 32 contains French contributions also; the chapters are on experimental methods for determining crystal structures by X-rays (in French) by A. Guinier and G. von Eller; on the theoretical principles of structural research by X-rays, by J. Bouman; on the study of the structure of liquids and amorphous substances by means of the diffusion of X-rays (also in French), by G. Fournet; on size of particles and lattice defects, by W. W. Beeman, P. Kaesberg, J. W. Anderegg and M. B. Webb; on electron diffraction (in German), by H. Raether; and lastly on neutron diffraction and interference, by G. R. Ringo. It is the last two chapters that necessitate 'Ångström radiation' instead of 'X-radiation' in the title of this review.

The names of the authors guarantee the quality and accuracy of the various chapters. Vol. 30 contains references up to 1956, but much of it has a curiously old-fashioned ring, as if it could have been written in the thirties without much difference. (The chapters on soft X-ray spectra and X-ray microscopy are clear exceptions.) In the field of emission spectra of medium wave-lengths, however, there are signs of a revival of interest. Sandström, in summing up the experimental results, states "These two effects [asymmetry and overlapping] raise the question of the definition of the wave-length of a line with a finite width. Usually the wave-length of the peak intensity is preferred as it is the one detail most easily identified. However, the centre of gravity of the area below the intensity distribution curve could also be chosen. . . . No X-ray wave-lengths have been determined with an accuracy better than ± 0·002 XU, which value has to be considered the ultimate limit of accuracy, systematic errors excluded. Some narrow lines in the region of medium wave-lengths excepted, the absolute value of the error certainly exceeds ± 0·004 XU. Considering the systematic errors, as well, errors 10 times as big are to be expected". The differences between peak and centre-of-gravity wave-lengths, and systematic errors of 4×10^{-5} A., are big enough to be disturbing in the type of counter diffractometry now being developed, and it is to be hoped that the needs of crystallographers will stimulate the spectroscopists, who are presumably better equipped for the undertaking, to push the systematic error into the next decimal place, and to produce reliable line profiles extending several half-widths on both sides of the peak.

I am a crystallographer, and I turned with some relief from the phenomenon to its applications. Guinier and von Eller's description of experimental techniques is characteristically lucid. Bouman manages to give the theory of almost everything from symmetry elements to intensity statistics, not excluding lattice distortion, in 140 pages. Fournet's chapter on amorphous states and that of Beeman *et al.* on small particles and lattice defects carry particular aspects of the theory considerably further, and supplement the experimental techniques on low-angle scattering. The chapters on diffraction of material particles contain much to fascinate the conventional X-ray worker.

The German and the English sections are indexed in both German and English in the two volumes. The French sections in Vol. 32, however, are indexed only in French, a fact that does not seem to be stated clearly anywhere, and was discovered empirically. There are copious references to the original papers by means of footnotes, and each chapter ends with a general bibliography. The bibliographical coverage seems very thorough; only two papers which I sought were not found mentioned in the expected places. There are no author indexes, so it could not be checked whether they appeared elsewhere. Altogether, these two volumes will be indispensable for the spectroscopist and the crystallographer, and each will learn much from the volume intended for the other.

A. J. C. WILSON

RADIATION PHYSICS IN MEDICINE

Radiological Physics

By M. E. J. Young. Pp. x+365. (London: H. K. Lewis and Co., Ltd., 1957.) 42*s*. net.

MEDICAL practitioners specializing in radiodiagnosis or radiotherapy require an understanding of certain aspects of radiation physics of a relatively advanced nature. There are few suitable text-books on the subject for doctors preparing for their professional examinations, and thus a new

work directed to their needs is welcome, particularly when it is as well written and presented as the volume under review. It should, moreover, be of value to a wider circle of readers, including new entrants to the field of medical physics.

After introductory chapters, the production of X-rays including those in the megavoltage region is considered in some detail, and is followed by an account of naturally occurring radioactive sources. There is one chapter on the interaction of X- and γ-rays with matter, while two are devoted mainly to methods of measurement of ionizing radiation but include discussion of the principles of dosimetry. A chapter on the physical principles of diagnostic radiography is followed by an account of the chemical and biological effects of radiation. The therapeutic uses of X- and γ-radiation are covered in some detail with examples of treatment planning. The production and medical applications of artificial radioisotopes are next described, and the final chapter deals with radiation hazards and protection. Each of the main chapters has a list of references and a selection of appropriate examination questions.

In general, the clarity and conciseness of expression are noteworthy, but the value of the book to students would be enhanced by more frequent use of cross-reference. The author has made allowance for differences in the mathematics and physics background of his readers by the use of small print for more advanced explanation, although this practice has not been followed entirely consistently.

Some misprints have been noted, such as the repeated use of 'Ce^{137}' when 'Cs^{137}' is intended and '8 mA' for '3 mA' in the fluoroscopy conditions in Table 9.01. One or two ambiguous or even erroneous statements have been overlooked, for example that X-ray pulses from a betatron have an interval of ¼ cycle, and it is unfortunate that the calculation on p. 199 relating to foreign-body localization is incorrect. These criticisms, however, relate to minor defects in a text-book that can be warmly recommended.

G. W. Reed

OCCUPATIONAL DISEASES

The Diseases of Occupations

By Donald Hunter. Second enlarged and revised edition. Pp. xvii+1100+16 plates. (London: English Universities Press, Ltd., 1957.) 105*s*. net.

DR. DONALD HUNTER is one of our most talented medical teachers, and few who have listened to his words can have failed to be impressed by his wide knowledge in the field of occupational medicine.

He has given us the benefit of his knowledge in a remarkable text-book, which, in its first edition, has already become the standard work on this subject in the British Isles. I venture to suggest that it should be read by all consultants, who will find it not only extremely entertaining but also a revelation of the wide variety of ways in which occupation can affect health.

In this second edition, eleven new illustrations have been added, making a total of 447, and certain additions and corrections have been made in the text, but the general layout and arrangement of the sections remain unchanged. The total number of pages is now 1,100 compared with 1,046 in the first edition. There are comprehensive bibliographies at the end of each chapter.

Several additions have been made to the first four chapters concerned with the history of the subject. These include sections on metal workers in Greek, Roman and Teutonic mythology, a description of Alexander Gordon's views on the cause of puerperal fever, the status of the lower middle classes, and the hey-day of the Lancashire cotton industry. There is a most useful and much-needed section on the importance of vital statistics and epidemiology, including the work of Dr. John Snow on cholera. Unfortunately there is no account of the present-day use of morbidity statistics in industry. This is a pity since so much has been done in recent years, particularly by such organizations as the London Transport Executive. A description of the value of this type of work would have been a welcome addition. There is no adequate account of the extremely valuable Occupational Mortality Supplement 1931 and the Supplement for 1951, based on a 1 per cent sample. There is a critical review of the findings of the Sadler Committee to inquire into the working conditions of children in factories. Due credit has now been given to the Perkins family of Leeds and their early discoveries in the dyestuffs industry.

These items are mentioned to indicate the vast field which has been covered in the historical section of the book.

The Factories Act 1948 is discussed, but unfortunately there is no mention of the fact that the examining surgeon is now called the appointed factory doctor.

There are new sections on the National Insurance Industrial Injuries Act, the work of the National Coal Board Medical Services and an excellent description of the workings of the Disabled Persons Employment Act. The value of health education in industry is given its due emphasis. In all the sections on toxicology one marvels at the wide knowledge of industrial processes possessed by the author; the section on lead poisoning is particularly informative and full of fascination even for a lay person. Additional information has been given concerning vanadium poisoning in relation to petroleum and to boiler cleaning. There are a few slight additions to the section on manganese poisoning.

There is a new section on cadmium poisoning in man and in experimental animals. The section on thallium poisoning is completely new. There is an excellent account of hazards in the iron and steel industry and a description of the Iron and Steel Foundries Regulations 1953. The new section on sewer men gives a graphic account of the hazards of this dangerous job and the cheerful disposition of those employed in it.

There is an up-to-date account of a nuclear power station and the dangers associated with it. In the next edition the public-health hazards might be discussed in more detail. In a book which is so comprehensive and which covers such a wide field it is almost inevitable that some minor items should be omitted.

Everyone concerned with the health of workers should have access to this book. Although it is written by a consulting physician primarily for medical men, parts of it could be read with profit and interest by any intelligent layman. I regard the price of £5 5*s*. as reasonable, providing very good value for money.

W. Hobson

ARCTIC AND ANTARCTIC

Arctic Research

The Current Status of Research and Some Immediate Problems in the North American Arctic and Subarctic. Edited by Diana Rowley. (Special publication No. 2 of the Arctic Institute of North America. Reprinted from *Arctic*, Vol. 7, Nos. 3 and 4.) Pp. 261. (Montreal: Arctic Institute of North America, 1955.) 3.50 dollars.

Arctic Frontiers

United States Explorations in the Far North. By Dr. John Edwards Caswell. Pp. xv+232+16 plates. (Norman, Oklahoma: University of Oklahoma Press, 1956.) 3.75 dollars.

Men against the Frozen North

By Ritchie Calder. Pp. 279+15 plates. (London: George Allen and Unwin, Ltd.; Toronto: Thomas Nelson and Sons (Canada), Ltd., 1957.) 16*s*. net.

Spring on an Arctic Island

By Katharine Scherman. Pp. xvi+331+12 plates. (London: Victor Gollancz, Ltd., 1956.) 18*s*. net.

THE higher latitudes, both north and south, in these days receive an amount and style of attention which is not altogether in accord with reality. Vestigial glamour, lack of perspective, research progress, public ignorance and polar beauty, are among the attitudes which characterize, with varying degrees of helpfulness, the arctic literature of to-day. The present four volumes under review are diverse in worth, style, and subject, and all will find grateful readers. But those readers will be distinctly varied in type and taste, some learned, others ignorant but eager to read if the fare is, as some would say, served in the contemporary manner. The first of these four volumes is an important work.

"Arctic Research" is a truly important compilation and reference book. Its twenty-six chapters, each with its list of references, are about equally divided between the physical, the biological and the social sciences. There is a most impressive list of field research projects sponsored by the Arctic Institute since its foundation.

This work was not intended to provide a complete picture of arctic research, not even of North American arctic research, at this date. That would have been a goal impossible of attainment. Rather was the attempt to define the present state of knowledge in a selected variety of fields where individuals of prominence are available to perform the task. The introduction is by the late Dr. R. C. Wallace, the executive director of the Arctic Institute from 1951 until his death in 1955. Dr. Wallace played a great and vigorous part in the continuing growth of this energetic joint Canadian and United States organization. But the brunt of the work, in the production of the volume and the assembling of the authors, is due to Mrs. Diana Rowley, the editor. Her task cannot have been easy: the result is admirable.

The chapters are naturally of varying quality, but in general it is distinctly high. Excessive verbosity, that intellectual disease of North America, has been fairly well controlled, though we are still presented with 'population enumeration' for 'census' and similar word wasters. The lists of references are not overloaded; indeed, in a few instances further references to the scientific literature of Europe might have been helpful.

Photographs are quite properly not numerous. There are four striking pictures of the retreat of the North Dawes glacier in Alaska between 1889 and 1950, a total of 6,500 feet.

This admirable volume may well be compared with "Problems of Polar Research" issued as Special Publication No. 7 of the American Geographical Society in 1928. That earlier work had a long and useful life, and so will "Arctic Research".

"Arctic Frontiers" describes the period of United States arctic explorations from 1850 to Peary's return from the attainment of the North Pole very nearly fifty years ago. As the author says, "This is the narrative, not of isolated adventures, but of a movement". This is an interesting and useful introductory record of what was afoot and when. The reader may well feel that he is perusing the competent précis of an extensive narrative; and that seems indeed to be so, the background work being the same author's study of "The Utilization of the Scientific Reports of the United States Arctic Expeditions 1850–1909".

"Men against the Frozen North" is a successor to the same author's two similarly titled books where our species is set as an adversary of deserts and jungles. This is not the place for detail. The author travelled very widely over the northern parts of the American continent, the Arctic Archipelago and Arctic Ocean. He did so in a very short time, and he is a scientific journalist of enthusiasm, discernment and repute. He knows full well that a large fraction of the population must be tempted to read by devices such as the use of direct speech and minor jokes, and that then information can be inserted like the filling of a sandwich. As *The Times* commented upon the on-stage disrobement of a revue star, "if you like that sort of thing; it is extremely well done".

"Spring on an Arctic Island" is by a woman author who spent six weeks in 1954 on Bylot Island off Northern Baffin Island in 73° north latitude. This is a simple, personal tale, well told by one to whom all was happy novelty. "Above all we got to know some Eskimos." There are some attractive photographs.

G. C. L. BERTRAM

POISONOUS PLANTS

The Toxic Plants of Western Australia

By C. A. Gardner and H. W. Bennetts. Pp. xxx+253+52 coloured plates. (Perth: West Australian Newspapers, Ltd., 1956.) £(A)2 10*s*.

THE rich and varied flora of Western Australia, which has so many affinities with the flora of the Cape in South Africa, is noted for the number of highly ornamental or beautiful plants that it contains. Unfortunately, it contains also a large number of species known to be poisonous. These have been the cause of loss and anxiety to stock-owners since the days of the earliest settlers. A great deal of knowledge regarding these harmful plants has been accumulated in recent years, thanks largely to the investigations of the two authors of this book. They have now produced, in a most scholarly fashion, what is the first comprehensive work on the poisonous plants of Western Australia. Both authors are eminent in their respective fields—botanical and veterinary—and together they have formed an ideal partnership for work of this kind. It is to be hoped that the toxic

plants in other parts of the world, particularly the less-developed countries, will be similarly dealt with.

The book has purposely been written in a manner that will enable pastoralists and farmers to recognize symptoms of poisoning and to identify the plants that may be responsible. It is well illustrated with coloured plates and line drawings. Each species is treated separately and a detailed description of it provided. This is followed by information on toxicity, symptoms and post-mortem appearances. An appendix lists the toxic plants likely to be found in each of the sixteen districts of Western Australia. Other appendixes give lists of the cyanogenetic plants and those known to cause photosensitivity, dermatitis and hay fever. As quite a number of the species dealt with occur in other parts of the world the book is likely to be of value in other countries.

F. N. Howes

WHEAT IN AUSTRALIA

The Wheat Industry in Australia

By Dr. A. R. Callaghan and Dr. A. J. Millington. Pp. viii+486. (Sydney and London: Angus and Robertson, Ltd., 1956.) 63*s*.

WHEAT is by far the most important crop in Australian agriculture, and next to wool it is the most valuable product. Australian wheat accounts for about 5 per cent of the world output, but its international significance is greater than this figure suggests, because Australia is one of the four major wheat-exporting countries. The history of wheat cultivation in Australia provides an excellent example of agricultural evolution; starting from an exhausting mono-culture on virgin land after clearing and burning the native vegetation, it was improved by the introduction of fallows and fertilizers, especially superphosphate, and more recently by diversified cropping and alternation with leguminous pasture, in an attempt to achieve stability of yield and to prevent soil erosion. The extensive cultivation of wheat with a minimum of man-power was made possible by the invention of special implements and machines adapted to local conditions. These are a few of the reasons that justify the publication of "the first comprehensive account of the Australian wheat industry".

This book is certainly comprehensive. It starts with a history of the establishment of agriculture in Australia, and its development up to the present. Some introductory chapters describe the climate and soils of the wheat lands, and discuss soil structure, plant nutrition and the use of fertilizers in general terms. There are a useful summary of Australian work on the effect of fallow and of leguminous crops on soil nitrogen, and an account of 'dry-farming', the benefits of which are shown to be due to conservation of nitrogen, not water, and to weed control. Variations in husbandry on the different soil types of the wheat belt, and possible future developments in cropping systems are discussed. There is a short general description of the morphological changes during growth of a wheat plant, not specifically related to Australian varieties or conditions. Later chapters deal with the improvement of wheat varieties by selection and breeding, wheat diseases, and the implements and machines used in wheat growing. The rest of the book, about a quarter of it, is concerned with non-agricultural topics, such as storage and marketing of grain, its conversion into flour and bread, and the economics of world trade in wheat. Some of these seem scarcely appropriate for a volume of the "Australian Agricultural and Livestock Series". The most conspicuous omission is the lack of any consideration of the quantitative physiology of growth of wheat plants, and the ecology of wheat crops that form the basis on which the wheat industry is built.

The book is lavishly illustrated with nearly 300 photographs, diagrams and graphs, but many of them have so little relevance to the theme, and others so nearly duplicate each other (for example, Figs. 140, 141 and 154) that they could have been omitted with little loss, and possibly some reduction in cost. It is full of factual information, clearly presented and critically discussed, and generally succeeds in its declared intention of giving "an overall appreciation of the industry and its problems"; but it could have been shorter, more selective, and more readable if the authors had written for a more restricted audience, and had not tried to meet the requirements of "the farmer, the specialist, the student and the general reader" all within the same volume.

D. J. Watson

COMMON LANDS

The Common Lands of Hampshire

By Dr. L. Ellis Tavener. Pp. vii+123+8 plates+7 maps. (Winchester: Hampshire County Council, 1957.) 21*s*.

WHEN the Royal Commission on Common Land began its work two years ago, the lack of accurate information on the status and distribution of common land in England and Wales was at once apparent. The official estimate of about 2,000,000 acres (of which 500,000 may be in Wales) was based on a return made so long ago as 1873, together with some later information on larger areas suitable for war-time reclamation. Only one county, Cambridge, had made a survey of commons as part of its planning survey. To remedy its own position, the Hampshire County Council commissioned Dr. L. E. Tavener, senior lecturer in geography in the University of Southampton, to carry out a factual study of common land in that county—excluding the New Forest, of which adequate details exist.

The county has published his findings in this handsome volume. Whereas he was provided with a provisional list of 90 commons covering 12,000 acres, he actually found at least 133 commons totalling nearly 17,000 acres, not including innumerable village greens of less than five acres which have not been listed.

A tabular analysis and succinct descriptions of commons by administrative areas are accompanied by a chapter on their soils, and a comparison of the maps in the folder shows clearly the close association of commons with coarse, hungry soils of the London and Hampshire Tertiary basins, and the western end of the Weald. Tavener's pioneer study is of far more than local interest. A careful glossary, an attempt to determine what is a common, an indication of sources of information—notably the enclosure awards—combine to make this an indispensable guide to others who, it is hoped, will take up the systematic study in other counties.

L. Dudley Stamp

Guided Missiles in War and Peace

By Nels A. Parson, jun. Pp. xii+161. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1956.) 28*s*. net.

THIS introductory study, by a member of the United States Army Ordnance Corps, attempts to show the impact of guided missiles on military operations and to describe the technical characteristics of the main classes of missile. The subject is treated at a technical level suitable for non-specialists; nevertheless the book gives a useful account of the basic principles of missile propulsion, aerodynamics and guidance, with clear diagrammatic illustrations. There is a strong tendency to advance the guided missile as the solution to almost every military problem of the future, although the need for specially trained man-power to operate and maintain the associated complex equipment is emphasized. Great importance is attached to the use of submarine-launched atomic missiles and to the provision of medium-range ballistic missiles for use by army commanders. Although, at the time the book was written, the speculations it contains on satellites and space travel may have seemed naïve, the last chapter on 'missiles of peace' has a topical ring in the light of recent events.

In general the book is typical of the spate of publications on missiles which have emanated from the United States in the past few years. For the inquiring layman, as for the soldier, sailor or airman, it gives a readable introduction to the subject, with a number of interesting photographs of American missiles and a summary review of the likely tactical and strategic uses of guided missiles.

Non-Stable Stars

Edited by George H. Herbig. (Symposium No. 3 of the International Astronomical Union.) Pp. viii+200. (Cambridge: At the University Press, 1957.) 30*s*. net.

THIS volume contains the talks given at a symposium of the General Assembly of the International Astronomical Union held in 1955 at Dublin. It is concerned mainly with stars which for one reason or another are thought to be unstable, or near instability, especially T Tauri stars, flare stars, novae, Wolf-Rayet stars, and eclipsing binaries.

Among the more interesting contributions are those on T Tauri stars, peculiar objects to which A. H. Joy first directed attention in 1945. They are dwarf stars, irregularly variable, with late-type spectra but showing emission lines, and associated closely with interstellar matter. At first their peculiarities were attributed solely to collision with gas clouds, but the association between stars and gas is now thought to be more than fortuitous. The general opinion is that these stars are young and, indeed, that we may be witnessing some stage in their formation. Another important paper is that by M. F. Walker, giving evidence for extremely rapid light variations in old novae, especially DQ Her, better known perhaps as Nova Herculis 1934. A. McKellar and R. M. Petrie give some valuable measures of spectrum line changes during ingress and egress in 31 Cyg, where a *B*5 star is eclipsed by a super-giant *K* star. The results show irregular structure and movement in the *K* star's atmosphere, giving us a decidedly more complicated picture than is usually contemplated in theory.

Much attention is given to ejection of matter by one component of an eclipsing binary and interception by the other. The opinion appears to be growing that some such mechanism is often operative, with a significant and possibly rapid effect on the evolution of the component stars. Z. Kopal reports some computations, based on a very simple model, to deduce the actual trajectories for gas particles from one star to the other. One may hope to see more work of this kind.

But valuable and interesting though these and other papers in this book may be, I have been left with a rather depressing suspicion that in this subject we have too many complications and too few significant facts, too much hopeful speculation and perhaps not enough hard thinking. We need new measurement techniques, deliberately designed to answer specific questions, and not merely for the purposeless collection of more data with which to confuse ourselves; and we need fresh theoretical ideas, rigorously worked out. If this symposium stimulates such developments it will have justified itself.

R. O. REDMAN

The Origins of Modern Science, 1300–1800

By Prof. H. Butterfield. New edition, revised and enlarged. Pp. x+242. (London: G. Bell and Sons, Ltd., 1957.) 16*s*. net.

IN view of its intrinsic value and the many appreciative reviews of the first edition, including that in *Nature* (165, 333; 1950), it is very fitting that "The Origins of Modern Science", published in 1949 and reprinted in 1950 and 1951, should now appear in a revised and enlarged form. Referring to the lectures which he delivered for the History of Science Committee in Cambridge in 1948, Prof. H. Butterfield writes, "In this revised edition they appear now with some of their original errors removed, some judgments altered, and some changes which reflect the advance of knowledge in the intervening years".

Thus, although this book retains its general plan, its value is enhanced by the author's considered judgment, which finds expression in revision and expansion, here and there, of the various chapters. A summary of the importance of the 'theory of impetus'; an appreciation of the contribution to modern science of fifteenth-century art; a discussion of the notion, brought to a climax in the eighteenth century, of 'the Great Chain of Being', are examples. Not least in value are the suggestions for further reading, which have also been brought up to date.

This new edition is specially welcome in a world which is still in need of the historian's as well as the scientist's point of view. H. D. ANTHONY

Pioneer of Sociology

The Life and Letters of Patrick Geddes. By Philip Mairet. Pp. xx+226. (London: Lund Humphries and Co., Ltd., 1957.) 21*s*. net.

TO convey a vivid and accurate impression of a personality so dynamic and many-sided as that of Patrick Geddes is no easy task, and though the thirty-odd letters Mr. Mairet allows himself in his two hundred or so pages appear to be well chosen and representative, they are scanty measure for the task. None the less, the book is well balanced and gives a clearer and more continuous picture of Geddes' whole life and work than Mr. Broadman's earlier book. In his final chapter Mr. Mairet attempts a brief but admirable appreciation of the significance of Geddes' work, and it is here in its exposition of the

contribution which Geddes' work and thought has made to the problems of to-day that the great merit of this book is to be found. Not simply in town and country planning, in the community centre and in like fields of sociology, but on a host of educational issues such as the multi-racial university (as Sir William Holford notes in his foreword), the functions and work of a university, the fragmentation of knowledge, halls of residence and technical assistance, Geddes had stimulating and sensible ideas, the reference of which in the context of to-day is apparent from Mr. Mairet's exposition. It is the more unfortunate, therefore, that the book is robbed of its full value by the omission to supply those bibliographical details which would enable the reader when interest is aroused to turn to Geddes' own writings and study for himself the implications of his thought. The book is also marred by some careless writing, inaccuracies of description, for example of the Committee of Intellectual Co-operation, and the index is erratic and might well be more complete. R. Brightman

Tree Injuries

Their Causes and Their Prevention. By H. L. Edlin and M. Nimmo. Pp. v+167. (London and New York: Thames and Hudson, Ltd., 1956.) 21*s*. net.

THE post-war boom in horticultural societies has had its parallel in a marked revival of interest in arboriculture, and for this type of reader the book under review can be strongly recommended. It is eminently readable, the information provided is thoroughly reliable and, above all, the 125 photographs provided are fascinating. With the text these should provide a means of recognizing and explaining all the common, and some uncommon, forms of damage and abnormality likely to be seen about the country, and should also serve as a warning of the harm that may be caused inadvertently by man. Some people may find life the duller for the sensible answer given to the perennial question as to what damage is done to a tree by ivy, but they may perhaps find compensation in becoming knowledgeable about many more recondite problems. It may be pedantic to quarrel with the classification of old age, coppicing, spiral grain, etc., as 'injuries', particularly as the book would be much the poorer for their omission, but this leads to a misleading impression that 'prevention', as mentioned in the title, is not very adequately covered. In fact, such measures as are possible for the prevention of diseases and defects are given with commendable brevity and practical sense.

More than seventy types of 'injury' are described, and these are grouped conveniently according to causes, such as climate, man, mammals and birds, insects, climbing and parasitic plants, fungi and old age, with a chapter on deformities and curiosities. A useful bibliography of about forty articles and books is included. L. Chalk

Insect Life in the Tropics

By T. W. Kirkpatrick. Pp. xiv+311. (London and New York: Longmans, Green and Co., Ltd., 1957.) 35*s*. net.

THIS book may reasonably be likened to a small text-book on entomology in which particular point is made of selecting from tropical forms of insect-life examples to illustrate principles in insect biology and behaviour. The author draws largely from his own experiences and observations in East Africa, Trinidad, Egypt and the Sudan. It is written primarily for the layman but contains so much information about different sorts of insects that it is likely to be helpful and of interest to the entomologist curious about insects beyond his speciality. The opening chapter considers briefly the nature of climates in the tropics. Two further chapters deal with the essentials of insect structure (mainly external), with some special reference to sensory organs, and the classification of insects to the level of orders. This is done in sufficient detail to satisfy the layman's aspirations to approach his hobby scientifically. The remainder of the book presents its subject from a biological point of view. Thus, the chapters are on the way insects develop, reproductive mechanisms, food and feeding habits, locomotion, defence and protection, insect social communities and the architecture of insect nests and termitaria. The book is well illustrated with 146 line drawings and photographs, well produced, and of a convenient size for travel.

Heat and Thermodynamics

An Intermediate Textbook for Students of Physics, Chemistry, and Engineering. By Prof. Mark W. Zemansky. Fourth Edition. Pp. xi+484. (London: McGraw-Hill Publishing Company, Ltd., 1957.) 56*s*. 6*d*.

AMONG the present glut of thermodynamical texts, Prof. M. W. Zemansky's book, in a refurbished edition, is still well among the best. It is, the author writes, aimed at physicists, chemists and engineers, but in fact it is most suited to the needs of physicists. It adheres rigidly to the classical approach, eschewing statistical mechanics and quantum theory, although certain facts have to be quoted from these subjects. This restriction does not prevent the author from discussing some of the most recent advances, notably in low-temperature physics. This topic, Zemansky's own speciality, occupies a new and extensive chapter which forms an excellent survey of the field but tends to spoil the balance of the book. Perhaps this will be redressed in a fifth edition with an equally long chapter on the increasingly fashionable problems of high-temperature plasma, undoubtedly of great thermodynamic interest. Ionized gas is studied briefly in the chapter on gas reactions. The concluding chapters on chemical thermodynamics and the phase rule, though very clear, are markedly more theoretical in approach than the physical chapters, which abound in experimental detail. The sections with relevance to engineering are probably the weakest, and the section on heat transfer is necessarily so brief as to be scarcely worth while. A greater emphasis on flow processes is desirable in a thermodynamical text-book for engineers.

The examples at the end of each chapter have been extended and improved. One's only criticism is that many are exercises in mathematics rather than applied physics.

Besides the discussion of low-temperature physics already mentioned, there are several new features in this edition. The faulty Kelvin treatment of the thermocouple has been superseded by the theory of coupled irreversible flows. The relation between information and entropy is touched on with tantalizing brevity. That the book should be so capable of continued development is testimony to the soundness of the original structure.

J. A. Shercliff

THE LONDON PLANETARIUM

By Dr. H. C. KING
Lecturer-in-Charge

H.R.H. the Duke of Edinburgh will be present at the initial lecture or presentation to be held at the new London Planetarium on March 19. After this inauguration the Planetarium will be opening its doors to the general public and offering as many as thirty-five presentations a week, each presentation lasting forty minutes.

The London Planetarium (Fig. 1) is the thirty-third Zeiss planetarium and the first large-scale project of its type in the British Commonwealth. The first was set up in 1924 on the roof of the Zeiss works at Jena, where in eighteen months some 80,000 visitors viewed the artificial heavens. The instrument was thereafter operated at the Deutsches Museum, Munich, and a second projector, later moved to the Haagsche Courant at The Hague, took its place. By 1928 Zeiss had installed twelve planetarium projectors at important sites in Germany and Austria. Rome had one in 1928 and Moscow followed suit in 1929: according to a recent report 20,000,000 visitors have so far visited the Moscow centre project. The first American planetarium, the Adler Planetarium, Chicago, was opened in May 1930. Its success was such that others appeared at Philadelphia (1933), Los Angeles and New York (1935), Pittsburgh (1939) and Chapel Hill, North Carolina (1949). During the 1930's Zeiss planetaria were also built at Stockholm, Milan, Osaka and Tokyo.

The instrument for London is one of a new series made at the Zeiss works at Oberkochen, Western Germany. As such, it is of the type recently assembled in São Paulo and Hamburg. Previously, only the brightest star, Sirius, had been reproduced by a special optical projector; but this system has now been extended and applied to all stars down to those of the second magnitude by the introduction of forty-two special projectors fitted to the main dumb-bell assembly (Fig. 2). Furthermore, the 32 star diapositives, which contain some 8,900 remaining stars and various nebulæ and star clusters, are no longer made of perforated copper foil but are produced by photo-chemical means on scratch-proof plates. New speeds of three and twelve minutes have been introduced into both the diurnal and annual movements, and the Moon projector has been improved to show a brighter Moon with characteristic maculæ.

The building can be likened to a large hollow mushroom having an outer skin of copper-covered concrete, and an inner dome of aluminium alloy. The domes both rest on a circular floor of reinforced concrete 24 in. thick, which in turn is supported by twelve columns. These columns are placed 11 ft. back from the perimeter and act as fulcra so that the mass of the concrete floor inside the circle of columns balances the cantilever plus the weight of the entire dome structure. The thrust downwards to the ground floor amounts to 145 tons per column, and this in turn is taken up by four piles to each column. The piles are 45 ft. long and have their tops 10 ft. below road-level.

The Metropolitan Railway runs along Marylebone Road at approximately 30 ft. from the edge of the building and the crown of the tunnel is some 6 ft. below road-level. Vibration from this source is so heavy that its effects can be heard in the present basement of Madame Tussaud's—some 150 ft. back. Moreover, the direction of the railway changes at the new building and curves away into Baker Street Station; as the trains slow down their wheels lock over to

Fig. 1. The London Planetarium

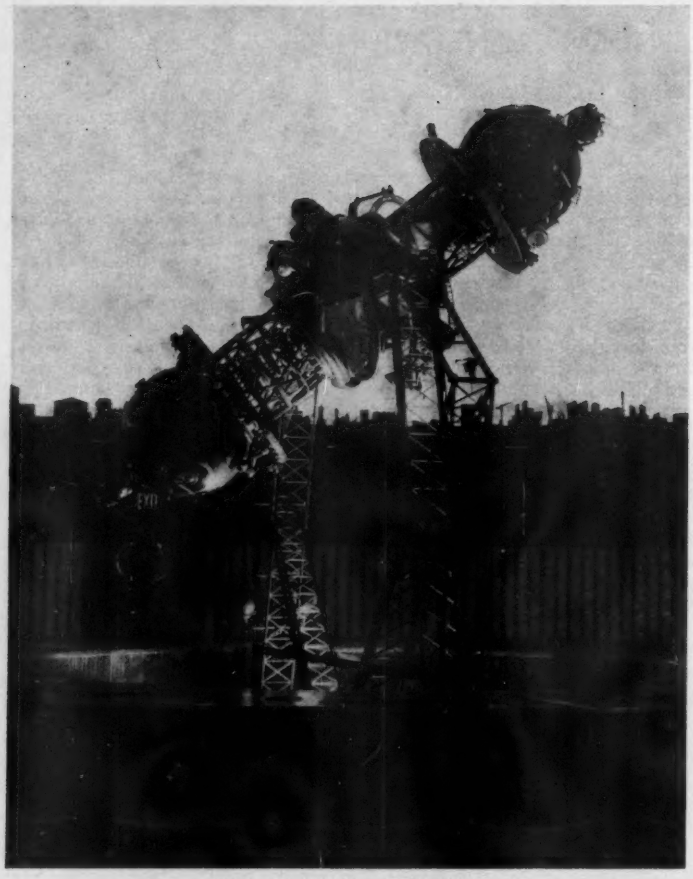


Fig. 2. The Zeiss dumb-bell projector

cause heavy reverberation. It was therefore decided that only weight would overcome ground vibration, and the engineers designed heavy concrete beams on a spider's web pattern. These beams connect up all the pile caps at 10 ft. below road surface and are topped off with an 18-in. thick concrete floor at ground-level. This scheme has proved highly successful. Not only is the floor of the auditorium free from transmitted vibration but also the sound of trains passing beneath is barely perceptible when the auditorium is empty.

In all other planetaria the central projector assembly is permanently mounted at the centre of the auditorium. At London, however, this assembly is carried by a vertical lift mechanism installed by Knight Construction, Ltd. When a lecture is not in progress, the instrument can be seen by the public in the brightly-lit foyer directly beneath the auditorium. In this 'down' position it is protected by a glass cage surround and a large overhead roller-blind. The sequence controls for the operation of the lift, lift blinds and lighting are at the lecturer's console near the northern face of the auditorium.

The auditorium has a seating capacity of 550 and can be given as many as eight changes of air every hour. Good optical projection makes it essential to enforce a 'No Smoking' ban and to filter the greater part of the incoming air. The projection dome, 67 ft. in diameter, is constructed of 16-gauge half-hard aluminium-alloy sheets formed with butt joints and screws to sixteen aluminium ribs. These ribs are held in position by two tubular tension rings and an upper aluminium saucer, and are bolted and insulated to a steel substructure at the bottom. To prevent echoes and reverberation, the sheets are perforated with holes 0·08 in. in diameter at a density of 20 per square inch and backed by a thick blanket of 'Rocksil'. These holes in no way prevent the audience from seeing even the smallest star images.

In most planetaria the blackness of the darkened projection dome can be relieved by a faint blue radiance provided by two special lamps fixed to the top members of the dumb-bell supports. In the London Planetarium this quite realistic auroral glow can be heightened by operating further lights concealed in the dais which surrounds the instrument, and by introducing blue and green 'effects lights' from behind the skyline. The effects lighting is carried out in three rings of cold-cathode tubes in red, green and blue (all concealed behind the plywood cut-out of the London skyline), and is controlled from the lecturer's console. The red lighting is used for special sunrise and sunset effects, and can be faded in or out together with or separate from the blue and green lights.

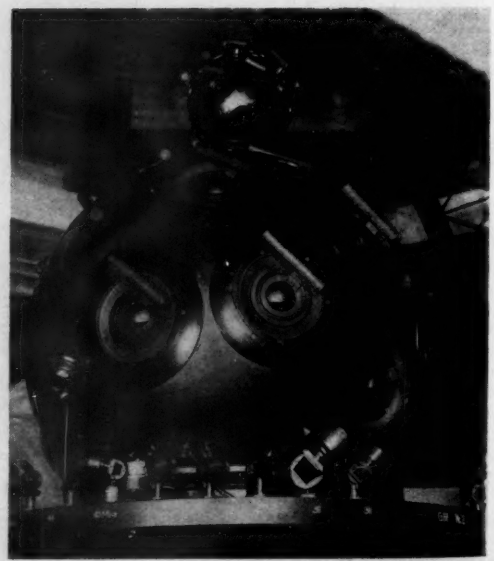


Fig. 3. Southern star globe and small globe for constellation names

Although the London Planetarium is owned by Madame Tussaud's, Ltd., it will operate as a separate entity from the Waxworks Exhibition. So far as the public is concerned, there will be no connexion between the two. It is also the first planetarium to be financed by and operated through private enterprise. As such, its presentations are designed to have the widest popular appeal and are not restricted to special times on just one or two days of the week.

The presentations will be at once entertaining and yet restricted to the facts and findings of astronomy. Each and every aspect of astronomy that the Zeiss equipment can cover will be treated with integrity and in proper context and sequence. The public, as B. J. Bok has remarked, will soon lose interest in presentations of scientific results if the fundamentals of scientific honesty are not strictly observed. School parties will be specially catered for in the morning and early afternoon presentations. Lectures on more advanced aspects of astronomy and courses of lectures on the fundamentals of practical astronomy and astro-navigation will undoubtedly follow in due course. How soon the normal programme can be extended into these most attractive fields will depend largely on the demand. For a year, at least, and until all the necessary technical staff is appointed, the operation of the basic programme with its monthly changes will receive priority.

The Planetarium has its own bookstall, and in addition to souvenir-brochures and booklets will later publish star-guides and low-priced books on elementary astronomy. The foyer will also contain display material arranged to interest the public in the findings of modern astronomy. When the new office block at the rear of the site is completed, the Planetarium will be able to offer an information service on matters astronomical to Press and public alike. It will by then have its own library and reference room, and also the necessary staff to deal with the anticipated heavy correspondence.

THE BRITISH NUCLEAR ENERGY CONFERENCE

SYMPOSIUM ON NUCLEAR ENERGY

SEVERAL chemical engineering aspects of atomic energy were discussed at the British Nuclear Energy Conference Symposium on Nuclear Energy which was held on January 21 in London. The symposium was sponsored by the Institution of Chemical Engineers, and the topics ranged from the problems which are involved when a nuclear power station of the Calder Hall type is started up, to the computation of the performance of solvent extraction columns which are used in purification processes for partially burnt nuclear fuel.

Sir John Cockcroft, as chairman of the Conference, opened the symposium, after which the chair for the morning session was taken by Mr. A. S. White (Atomic Energy Research Establishment, Harwell). Mr. H. G. Davey (United Kingdom Atomic Energy Authority, Windscale) presented the first paper on the "Commissioning and Operation of 'A' Station, Calder Works". Only a short time was available for commissioning the first of the two reactors in 'A' Station, and experimental measurements were restricted to those which would provide essential data. These included making measurements to determine the critical size and to find the optimum number and disposition of control rods required in the fully loaded reactor. These data were substantially supplemented by a more detailed experimental programme during the commissioning of the second reactor.

A cylindrical loading pattern was used, and the critical mass found to be the equivalent of 406 channels as compared with the predicted 475 channels, the difference being almost within the estimated error. A value of $k_{\text{eff.}} = 1{\cdot}0547$ was derived from experimental measurements, compared with the design figure of 1·042. The 48 control rods were calibrated by taking advantage of the closed pressurized cooling circuit to maintain the reactor in a critical condition, by adjusting the air pressure within the pressure vessel.

To ensure successful operation of the plant, it was necessary to test the coolant gas flow-rates through individual fuel channels, the gas leakage, the blowers, the gas circuit and the burst cartridge detection gear. Mr. Davey went on to discuss the work-up to power on August 1, 1956, and the approach to the maximum cartridge temperature of 375° C. on August 27, when the first turbine set was synchronized and loaded up. The second set was commissioned a week later and an electrical load of about 28 MW. was achieved with a reactor heat output of 136 MW. Steady conditions were maintained during September and early October and the official opening by H.M. the Queen was held on October 17, 1956, with the same operating conditions. A deliberate shut-down took place on November 15 and various modifications were made. Afterwards, near design conditions were obtained with an electrical output of 42 MW. at a heat output of 180 MW., with a maximum cartridge temperature of 408° C. The power output was eventually increased to 200 MW. heat in late August 1957. Mr. Davey gave sufficient information to demonstrate that Calder 'A' Station was not difficult to commission and, in fact, most of the teething troubles arose on the more conventional items of equipment.

In his paper on the "Development of the Butex Process for the Industrial Separation of Plutonium from Nuclear Reactor Fuels", Mr. C. M. Nicholls (Harwell) described the work which had been done in the Chalk River Laboratories prior to building the Windscale plant. Development of the Butex (diethylene glycol dibutyl ether) process, which was begun by a chemical team, was continued until proved by pilot-plant operation. The preferred process is one in which the fission products are eliminated by an early stage in a stream which is practically free from dissolved salts. Column studies were carried out, using uranyl nitrate, to study mechanical design details of solvent extraction columns, to provide information on the extraction

performance of columns and to check the flow-sheet so far as possible. Some of these studies were repeated, using uranyl nitrate solutions containing trace quantities of plutonium.

The design of the radioactive pilot plant was largely governed by: (*a*) the limitations imposed by the radioactive and toxic nature of the materials handled; (*b*) the novelty of the process; (*c*) the need for versatility in the plant; (*d*) the urgency of the situation; and (*e*) the limited staff and laboratory facilities and restricted space. Mr. Nicholls discussed the effects of these conditions and outlined the form of the plant and flow-sheets. Typical extraction results were given, but it was stressed that the main object of the operations was not to obtain the best overall plant performance but to study the extraction at each stage of the process and to obtain results which could give information for the design of a production plant. The development of production-scale equipment was undertaken by a team from Imperial Chemical Industries, Ltd. The value of the help and consideration given to the United Kingdom team by the Canadians at Chalk River was emphasized by Mr. Nicholls.

In discussing this paper, Mr. Davey described the process development as a remarkable piece of work and emphasized the similarity of both plant and flow-sheets with the present Windscale plant. The salt-free highly radioactive effluent was a feature of great importance, since it enabled the volume of the highly radioactive stream to be reduced 40–50-fold by evaporation before storage. The use of simple types of column had contributed to trouble-free operation, and Mr. Davey said that he was not so enthusiastic about suggested departures to other types of equipment which may lead to more efficient extraction but also to more trouble in operation.

Dr. E. Lofthouse (Imperial Chemical Industries, Widnes), as a member of the Imperial Chemical Industries team which had assisted in the development of the Butex process, pointed out the importance of finding, at Chalk River, that the plutonium extraction was at least as efficient as that of uranium, and this greatly aided the scaling-up work.

"Fission Product Disposal" was discussed by K. Saddington (Windscale). As an inevitable consequence of the operation of nuclear reactors, significant amounts of fission products are formed. The problem of the disposal of unwanted radioactive products will increase with increasing utilization of nuclear power. The problem is finally solved only by complete natural radioactive decay, but this process will take hundreds of years. The alternative methods of tackling the intermediate problem are: (*a*) complete containment (safe storage); and (*b*) dispersion in such a way that, by natural or other causes, the waste is greatly diluted. At Windscale, the highly active waste is concentrated by evaporation prior to storage. Evaporation raises issues of nitric acid removal, and destruction by the addition of formaldehyde may be used as well as steam or vacuum evaporation. The separation of specific fission products from this waste may provide useful radiation sources (cæsium-137 and strontium-90), but the residual solution must still be stored for lengthy periods, since it also contains long-lived alpha-emitting isotopes. Both American and British developments in dealing with highly active effluents were described. They included cation exchange on montmorillonite clays and fused salt calcination.

Medium active liquors may be treated by alumina floc adsorption (as at Windscale) or by alternative coprecipitation processes. After flocculation with alumina, 92–95 per cent of the total β–γ activity and 98 per cent of the trace plutonium are removed. The filtrate is monitored and discharged to sea. American practices include direct ground disposal using the ion-exchange properties of the latter. The small geographical area and dense population of Great Britain probably exclude such methods in this country. Low-active effluent may be discharged directly, or discharge may follow chemical pretreatment. The problem is the same in all cases, to discharge the liquors at such a rate and to a pattern which is defined so as to safeguard the public health and convenience in the widest sense.

Dr. E. Glueckauf (Harwell) discussed alternative methods of nitric acid destruction or removal such as electro-deionization methods. He described work being done at Harwell to fix fission products in the form of insoluble glasses from which the activity could not be released. Mr. Grover (Harwell) mentioned that pilot-plant work was being done in the Chemical Engineering Division at Harwell to convert fission products to glasses.

Sir Hugh Beaver was chairman of the afternoon session. The first paper, on "Nuclear Criticality in Chemical Plants", was preceded by a film entitled "Criticality". This described aspects of process plant criticality in terms which could be understood by plant personnel having little scientific training. Dr. A. H. Gillieson (United Kingdom Atomic Energy Authority, Risley) then presented the paper by himself and Mr. Nicholls. A criticality accident with fissile materials could lead to hazards to plant operators and damage to the plant. Dr. Gillieson briefly reviewed the relevant neutron physics and discussed methods for the safe design of geometrically simple, isolated solution systems. This can be achieved by limitation of the mass, volume or concentration of fissile material in solution or, preferably, by selection of the shape of plant. Geometrically complex systems and the influence on safety of choice of process and plant operation were briefly discussed.

A welcome speaker was Monsieur R. Galley (Commissariat à l'Energie Atomique, Paris), who read his paper on the "Marcoule Plutonium Plant". M. Galley gave a well-illustrated account of the plant, which is based on a tributyl phosphate extraction process. He included interesting details of plant construction, operation, analytical facilities and control, and allied problems of effluent disposal, etc.

"Fuel Processing in Homogeneous Aqueous Reactors", by Mr. I. Wells (Harwell) and Dr. E. Lofthouse, was presented by Mr. Wells. He summarized the relevant features of this type of reactor and discussed the special processing problems involved. It is necessary to keep to a minimum the wasteful absorption of neutrons in order that more fissile material is produced than is burnt (that is, for 'breeding' to be possible). This, and the need for chemical and radiation stability, limits the number of chemical compounds suitable as fissile and fertile materials. Mr. Wells described gas–liquid processing to remove volatile fission products, and solid–liquid separations by cyclones to remove precipitated fission product compounds. Alternative methods of chemical processing include solvent extraction and uranium peroxide precipitation. Mr. Wells concluded that it will be some time before such reactors are applied commercially, since many problems still have to be

overcome, for example, the containment of fluids, the handling of slurries and the maintenance of equipment in high-radiation fields.

The final paper in the symposium, on the "Computation of the Performance of a Multicomponent Solvent Extraction System" by Dr. J. T. Wood (Risley) and Mr. J. A. Williams (Windscale), was read by Mr. Williams. He showed how established methods of graphical calculation for immiscible phases may be applied to a complex multicomponent solvent extraction system such as the first extractor of a tributyl phosphate process for irradiated uranium. Partition coefficients for the main components were presented and Mr. Williams demonstrated their use in the calculation of extractor performance. Typical results were illustrated, and the choice of operating conditions, as determined by the behaviour of individual components, was discussed. In conclusion, Mr. Williams pointed out that while the broad outlines of a process can be calculated by the means described it must be emphasized that a reliable prediction of performance can only be made when all the partition data required are available. In some cases (for example, plutonium and ruthenium) it may be necessary to consider kinetic as well as partition effects, and it is more satisfactory to obtain detailed knowledge by experiment under conditions closely approximating, with respect to time of residence and flow ratios, to those of the plant.

F. S. MARTIN

RUDOLF DIESEL, 1858-1913

By E. J. HOLMGREN

AT present the world is passing through a great phase of scientific discovery that commenced with the end of the Second World War. Mankind has seen such periodic surges of scientific achievement before, at which times remarkable discoveries and developments take place that have profound effects upon the subsequent achievements of man. Just such an upsurge occurred in the closing decades of the nineteenth century and the opening years of the twentieth—years which we associate with such names as Parsons, Nobel, Edison, Fleming and many others. It was an age of great scientific pride and perhaps one of the most notable advances (and certainly one that has in recent years seen spectacular changes) was the advent of the compression-ignition engine as a prime mover with its notable promoter, Rudolf Diesel.

Diesel was born in Paris on March 18, 1858, of Bavarian parents. He spent most of his early years in that city, but on the outbreak of the Franco–Prussian War his family's fortunes were ruined and he was sent to England to school in 1870. Later that year he was sent to Augsburg, where he studied at the Technical School, and in 1880 he graduated from the Technical University with record marks. His one ambition was to become an engineer, and after graduating he worked for Prof. von Linde on the development of machinery for liquefying air.

This was the era in which the reciprocating steam engine reached its greatest development; the steam turbine had yet to appear. Diesel, however, as he worked both in the university and with von Linde, was not satisfied with the steam engine. Not only was it inefficient but also the cost per unit of power was much higher for the smaller than for the larger engines, so that it was an economical proposition only in the larger units.

During his undergraduate years Diesel had first become interested in the Carnot cycle of the theoretically perfect steam engine. He realized that this cycle must be applied in some way to provide a prime mover which did away with the faults of the steam engine. At first he designed an engine to run on ammonia gas in a manner similar to that of the steam engine, but while this was not satisfactory, mainly because of leakage of the gas, it demonstrated that a small economical engine was a possibility.

As a result of his experiments with the ammonia engine, Diesel came to four conclusions: (1) the idea of an engine on the pattern of a steam engine had to be discarded; (2) combustion of the fuel must be in the cylinder of the engine and not in a boiler; (3) air must be used as a working medium instead of steam; (4) high compression is necessary in order that the Carnot cycle be realized. It should be noted in passing that the concept of the compression-ignition engine was not new. In 1896 Charles Arkroyd Stuart had taken out his first patent, and had conceived the idea of fuel injection with compressed air, using a hot bulb as the means of ignition. Diesel dispensed with the hot bulb altogether. Later, Arkroyd Stuart applied for a patent covering automatic injection.

Prior to this time gas engines working on the four-stroke Otto cycle were the only internal combustion engines, and they all employed low compression ratios. With Diesel's engine, high compression was to be a necessity: it was to produce heat so that when the fuel (at first powdered coal was envisaged) was introduced, combustion would take place; this could be controlled. No air–oil mixture could be introduced or a premature explosion would result.

In 1893, with financial backing from Krupp's and the Augsburg–Nuremburg Engine Works, Diesel constructed his first engine. This was a single-cylinder machine with an external crosshead, working on the four-stroke cycle. The cylinder was not water-jacketed. The engine was driven by external power and when the fuel oil was introduced there was an explosion and the indicator was shattered. The engine, though a failure, served to demonstrate that compression could ignite fuel oil. In a second engine, Diesel introduced certain modifications such as a higher cam-shaft and a water-cooled cylinder jacket. This engine ran for only a minute. The third and fourth engines, built in 1897 and 1898, respectively, were more successful: the latter, although it was only a single-cylinder machine, developed 20–25 h.p.

The success of these experiments, which had been carried on at the Augsburg Engine Works since 1894, with the subsequent triumph of the engine as a workable machine, caused a world-wide sensation. Diesel engines began to be constructed in all parts of

the world under licence, for Diesel himself still possessed the patents. Unfortunately, at the turn of the century a number of minor mishaps on one or two machines caused Diesel considerable embarrassment and some financial reverse, during which he sold many of his patents; only later did he realize his mistake.

After 1901 a number of refinements were introduced. Machines of several cylinders were built; trunk pistons were introduced. The four-stroke cycle remained supreme and the oil was injected with the aid of compressed air, that is to say, a mixture of oil and air was introduced at the top of the compression stroke, for which purpose the engine had to be equipped with an air pump. Diesel himself saw the advantages of airless injection, and also of the two-stroke cycle which was peculiarly suitable for his engine. Its advent was delayed for two decades following his initial success because no manufacturer could build a workable fuel-injection pump capable of withstanding the high pressures involved. It was airless injection that made possible the success of the Diesel engine as we know it to-day, particularly in respect to the smaller sizes. Ironically enough, the small-size Diesel engine was not realized as quickly as Diesel had hoped, partly because of the introduction and success of the electric motor.

In 1912, Diesel visited the United States and addressed the American Society of Mechanical Engineers. At this time he was broken both in health and financially, and his death a year later, although mysterious, is generally attributed to suicide.

Diesel's invention can be regarded as comparable in importance to that of the steam engine. It is interesting to note that Diesel foresaw that his engine would eventually change the railways. However, at the time of its introduction the steam locomotive reigned supreme and another twenty-five years had to pass before the railways took any serious interest in Diesel locomotives. Diesel visualized his engine driving locomotives through a mechanical drive rather than through the intermediary of an electric generator and motor. Mechanical transmission was to come into its own, however, in rail cars and small switching engines.

The story of the Diesel engine in construction equipment, marine applications and road transport is well known. The success of the Diesel engine in the First World War in submarines and in the marine world in general gave it an assured place as a prime mover. In road transport, it is interesting to note that Diesel himself designed a road truck but later withdrew it. The early success of the petrol engine in Canada and the United States overshadowed the smaller Diesel engine, which, however, achieved some popularity in Europe. In Germany and Britain Diesel aero-engines made their appearance before the Second World War and were very successful, but gave way to the gas turbine when it appeared.

PROGRESS OF SPUTNIK 2 (1957β)

By D. G. KING-HELE

Royal Aircraft Establishment, Farnborough

SPUTNIK 2 has now been circling the Earth for more than four months, and sufficient observations have been received and analysed to allow a preliminary report on its progress to be made.

Fig. 1 shows how its period of revolution has altered during this time. A marked change in the slope of the curve is apparent between December 20 and January 5, and there are several smaller fluctuations in slope, which are not visible on the scale of Fig. 1. Until mid-December the rate of decrease of period remained fairly constant at about 3·0 sec. a day. There followed a sharp rise to about 4·0 sec. a day in early January. During January the rate fluctuated between 4·4 and 3·9 sec. a day; then in

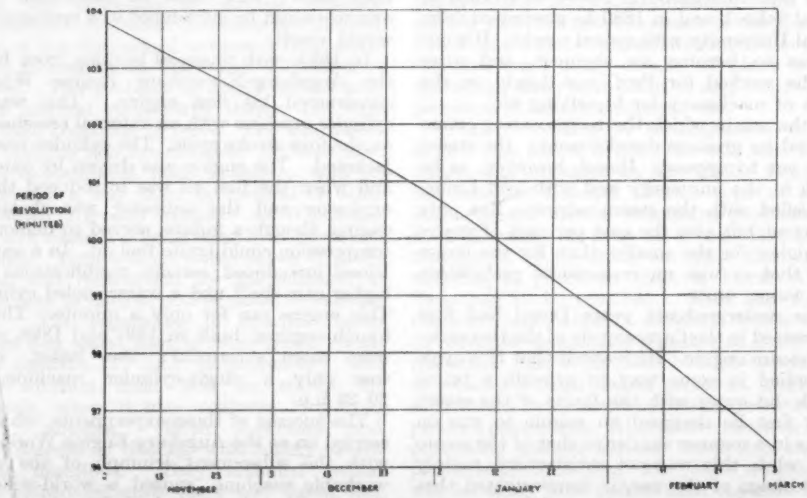


Fig. 1. Variation of the (nodal) period of Sputnik 2 between November 1957 and March 1958

Table 1. Orbital Data for Sputnik 2

Date	November 9, 1957	December 3, 1957	January 22, 1958	March 2, 1958
Time, G.M.T.	05.23 hr.	07.28 hr.	19.23 hr.	16.00 hr.
Orbital period (min.)	103·49 ± 0·05	102·289 ± 0·001	99·206 ± 0·001	96·33 ± 0·01
Semi-major axis (nautical miles)	3,940·2 ± 1·3	3,909·72 ± 0·06	3,830·77 ± 0·06	3,756·5 ± 0·3
Eccentricity	0·0973 ± 0·0004	0·0904 ± 0·0003	0·0728 ± 0·0005	0·055*
Angle from apex to perigee	− 33° ± 1°	− 41·9° ± 0·2°	− 63·19° ± 0·06°	− 83°*

Inclination of orbital plane to equator: 65·29° ± 0·03°.
The rate of rotation of the orbital plane about the Earth's axis was 2·69 ± 0·01 degrees/day at 00.00 hr. on December 1, 1957, and 2·88 ± 0·01 degrees/day at 00.00 hr. on January 20, 1958.
* Accuracy uncertain.

February there was a further rise, from 3·9 to more than 5 sec. a day, followed by a fall to about 4·5 sec. a day. These fluctuations are believed to be genuine and not due to observational error. They imply fluctuations in the effective drag on the satellite, and their interpretation should provide much scope for ingenuity. There have also been striking fluctuations in the apparent brightness of the satellite, often with a period of the order of one minute, and these have generally been attributed to its rotation.

The fluctuations in drag have made it difficult to predict the movements of the satellite accurately, and any estimates of life-time are subject to considerable error. At present the most likely date for the final descent through the atmosphere appears to be April 15; but if the drag were to change abruptly by 20 per cent, as it has done in the past, this date could be in error by up to 10 days.

When Sputnik 2 began its career the orbit had an eccentricity of about 0·1 and the height varied between a minimum of 120 nautical miles and a maximum of 900 nautical miles (1 nautical mile = 6,080 ft.). The satellite was at perigee when going north at a latitude of about 51° N. By the beginning of March 1958, the eccentricity had fallen to about 0·056 and the height varied between 110 and 530 nautical miles. Meanwhile perigee shifted slowly backwards along the orbit, and by the beginning of March had nearly reached the equator. The inclination of the orbital plane to the equator has remained virtually constant, as was expected from theory.

Fig. 1 and the orbital data given in Table 1 are derived partly from the many independent observations on which the prediction service for Sputnik 2 relies, and partly from observations made by kine-theodolite stations of the Royal Aircraft Establishment. I would like to thank all those concerned in the observations and analysis for the help they have given, often in the dark hours before dawn.

NEWS and VIEWS

Royal Society of Edinburgh: New Fellows

At the ordinary meeting of the Royal Society of Edinburgh, held on March 3, the following were elected Fellows of the Society: Prof. H. A. Brück, Astronomer Royal for Scotland and professor of astronomy in the University of Edinburgh; Dr. W. K. Burton, lecturer in natural philosophy, University of Glasgow; Mr. W. McL. Dewar, headmaster, George Heriot's School, Edinburgh; Mr. W. E. J. Farvis, head of the Postgraduate School in Electronics and Radio and senior lecturer, Department of Engineering, University of Edinburgh; Dr. D. Finlayson, research superintendent, British Celanese, Ltd.; Dr. A. R. Hill, lecturer in agricultural zoology, University of Glasgow; Dr. D. K. McE. Kevan, lecturer in agricultural zoology and head of the zoology section, School of Agriculture, University of Nottingham, recently appointed to the chair of entomology, McGill University; Dr. I. R. W. Lominski, senior lecturer in bacteriology, University of Glasgow; Dr. A. McDiarmid, principal scientific officer (veterinary science), Agricultural Research Council Field Station; Dr. Sheila Macintyre, lecturer in mathematics, University of Aberdeen; Prof. D. McKie, professor in the history and philosophy of science in the University of London; Mr. J. P. Maule, director, Commonwealth Bureau of Animal Breeding and Genetics; Dr. A. Meiklejohn, senior lecturer in industrial health in the University of Glasgow; Prof. R. Meredith, professor of textile technology, Royal College of Science and Technology, Glasgow; Dr. Mary J. McD. Noble, principal scientific officer (plant pathologist), Department of Agriculture for Scotland; Dr. D. V. Osborne, lecturer in natural philosophy, University of St. Andrews; Dr. R. Osborne, principal scientific officer, Poultry Research Centre, Agricultural Research Council; Dr. R. V. Rajam, director, Department of Venereal Diseases, Government General Hospital, Madras; Prof. R. A. Raphael, regius professor of chemistry in the University of Glasgow; Prof. I. N. Sneddon, Simson professor of mathematics in the University of Glasgow; Prof. F. S. Spring, Freeland professor in the Royal College of Science and Technology, Glasgow; Mr. J. N. Toothill, general manager, Ferranti, Ltd., Edinburgh; Dr. C. D. Waterston, assistant keeper in charge of the Department of Geology, Royal Scottish Museum; Prof. A. Williams, professor of geology in The Queen's University, Belfast; Prof. M. F. A. Woodruff, professor of surgical science, University of Edinburgh.

NATO Science Committee

The following national representatives on the North Atlantic Treaty Organization Science Committee have recently been nominated: Prof. C. Alexopoulos (Greece); Prof. F. Giordani, professor of general chemistry in the University of Naples (Italy); Prof. R. F. Mayer, vice-rector of Lisbon Technical University (Portugal); Prof. I. I. Rabi, professor of physics in Columbia University (United States); Prof. P. B. Rehberg, University of Copenhagen (Denmark); Prof. S. Rosseland, professor of

astrophysics in the University of Oslo (Norway); Prof. A. Rucker, rector of the Munich Technical High School (Germany); Prof. S. J. Sizoo, professor of chemistry in the University of Amsterdam (Holland); Sir Solly Zuckerman, Sands Cox professor of anatomy in the University of Birmingham (United Kingdom); Dr. E. W. R. Steacie, president of the National Research Council of Canada (Canada).

Astronomy at Cambridge : Sir Harold Jeffreys, F.R.S.

Sir Harold Jeffreys, who is to retire from the Plumian professorship of astronomy and experimental philosophy in the University of Cambridge in October, is best known for his work on physics of the Earth and in particular for his discussion of seismological observations and the deduction of the times of travel for earthquake waves. While this work on earthquakes was for many years the centre of his interest, there is scarcely any branch of science connected with the physics of the Earth to which he has not contributed, his work on its thermal history, on stresses in the crust and on tidal friction being particularly well known. The three editions of his book, "The Earth", have for thirty years been the best-known exposition of the application of physics and mathematics to our planet. In the course of his work on earthquake waves, Jeffreys met severe statistical difficulties arising from the failure of the observations to conform to the Gaussian law of errors. This led him to make an extensive study of the basis of the theory of probability and to write a stimulating and entertaining book on the subject. As was to be expected, this led to a vigorous controversy with the guardians of statistical orthodoxy. Jeffreys has also written several books on mathematical topics, including the widely known "Mathematical Methods", which is a joint work with Lady Jeffreys. Since he was appointed to the Plumian professorship in 1946, Jeffreys has devoted his attention mainly to the relation between the Earth's internal structure and astronomical quantities; in particular, he has studied the effect of the Earth's fluid core on nutation.

Prof. F. Hoyle, F.R.S.

Mr. Fred Hoyle, who has been elected to succeed Sir Harold Jeffreys as Plumian professor of astronomy and experimental philosophy, is well known through his many substantial contributions to modern theoretical astrophysics. After an early start in quantum theory, Mr. Hoyle, in collaboration with Dr. R. A. Lyttleton, began to turn his attention to theoretical astrophysics shortly before the Second World War. His outstanding gift of physical intuition has enabled him to appreciate the vital factors in astrophysical situations that are far from terrestrial experience. In this way he has been able to make far-reaching contributions to the theories of stellar structure and evolution, of galactic evolution, of star formation, and of cosmology. Mr. Hoyle has kept in close contact with the outstanding observational astronomers who are associated with the Mount Wilson and Palomar Observatories, and has spent a good deal of his time with them in Pasadena. In this way his theoretical work is backed by an up-to-the-minute knowledge of the latest observational results. The great depth of his understanding has made Mr. Hoyle an outstanding popular writer and broadcaster on astronomical and other topics. He has in the past added great distinction to astronomy in Cambridge as Fellow of St. John's College and lecturer in mathematics, and will continue to do so now in his professorial position.

U.S. National Astronomical Observatory : Dr. A. B. Meinel

Dr. Aden B. Meinel has been appointed director of the proposed new U.S. National Astronomical Observatory by the National Science Foundation in conjunction with the Association of Universities for Research in Astronomy, Inc., which is under contract to the Foundation for the establishment and operation of the observatory at a site to be selected in Arizona (see *Nature* of January 25, p. 236). Dr. Meinel received his Ph.D. in astronomy from the University of California in 1949. He joined the Department of Astrophysics of the University of Chicago in 1950, where he was appointed associate professor. In 1953 he was made associate director of the Yerkes and McDonald Observatories. Dr. Meinel's published work, in addition to optical design, spectroscopy of night airglow and aurora borealis, has included the identification of new band systems in the spectra of OH and N_2, detection of extraterrestrial protons in the aurora, and reproduction of the auroral spectrum in the laboratory by the use of accelerated particles. He has received the Lomb Prize of the Optical Society of America and the Helen Warner award of the American Astronomical Society in 1954.

Dr. Meinel has been associated with the project for the new observatory almost since its inception. He has served as full-time executive secretary to the *ad hoc* advisory panel of astronomers set up to make recommendations on a suitable site. Early in the spring of 1955 he began field work for the selection of possible sites in the south-western area. Assisted by H. A. Abt, Dr. Meinel made a comprehensive examination of the entire region bounded by the Rio Grande on the east, by latitude 36° on the north, and the geographical limits of the United States on the south and west. All available high-altitude rocket photographs were carefully examined. The two scientists flew thousands of miles in a small plane and travelled great distances by car in the course of examining every possible site. Dr. Meinel will continue to direct work on the new observatory from his present field office in Phoenix, Arizona, until a site has been selected.

Social Medicine at Aberdeen : Prof. E. M. Backett

Dr. E. Maurice Backett, who has recently been appointed professor of social medicine in the University of Aberdeen, is forty-two. He graduated in medicine at the Westminster Hospital (University of London) and holds an honours degree in psychology, a diploma in public health, and is a member of the Royal College of Physicians. During the Second World War he served in the R.A.F. (Science Branch). After qualification, he became a Nuffield Fellow in Social Medicine and carried out some work for the Medical Research Council. He was appointed a lecturer in The Queen's University, Belfast, and a senior lecturer at Guy's Hospital Medical School and the London School of Hygiene and Tropical Medicine, jointly. In this post he has been able to develop his interests in undergraduate teaching and also to carry out various investigations, especially in the organization of medical services; quality of medical care; morbidity studies in general practice; social factors in the distribution of polio virus; medical care of deaf mutes; epidemiology of road accidents; and coronary disease in doctors.

Graham Kerr Memorial

A COMMITTEE has been formed to promote a fund for a memorial to the late Sir John Graham Kerr, who occupied the regius chair of zoology in the University of Glasgow from 1902 until 1935. Lord Boyd Orr, chancellor of the University, has agreed to preside over the committee composed of the following friends and colleagues: Viscountess Davidson, Dr. Muriel Robertson, Sister Monica Taylor, Dr. G. S. Carter, Dr. H. B. Cott, Sir James Gray, Dr. Edward Hindle, Dr. R. A. Staig and Prof. C. M. Yonge. The form of the memorial will depend on the amount collected; but it is hoped that it will provide for the erection of a plaque and the endowment of an annual prize in zoology. Contributions should be sent as soon as possible to the Hon. Secretary and Treasurer, Miss A. E. Miller, Department of Zoology, The University, Glasgow, W.2.

Sir William Siemens Exhibition

A SMALL exhibition presenting the life and work of Sir William Siemens was opened at the Science Museum, South Kensington, on March 10. Prepared in collaboration with Siemens Edison Swan, Ltd., it is based upon exhibits collected together for display at the Central Hall, Westminster, on the occasion of the Siemens Bros. Centenary Lecture on March 5. Charles William Siemens was an outstanding figure in the industrial development of the nineteenth century, combining scientific insight and technical ability with an unusual degree of commercial acumen. He was an acknowledged pioneer of the electrical industry, both on the telegraph and supply sides; and his application of his regenerative furnace to metallurgy made him a leader also of the steel-manufacturing industry The exhibition traces his career and achievements in a chronological sequence. The early years, up to his election to the Royal Society, are represented by exhibits relating to his inventions during that period, and to the beginnings of his work with submarine cables. His later work is represented by exhibits dealing with the practice of steel manufacture and with the development of the electrical industry, including his work on the self-excited generator.

Directory of Societies for Natural History and Cognate Studies

THE Council of the British Association for the Advancement of Science has decided, at the invitation and with the financial assistance of the Carnegie United Kingdom Trust, to undertake the publication of a new edition of the "Directory of Natural History Societies", which was first published in 1948 by the Amateur Entomologists' Society. The "Directory" will cover archæological, astronomical, biological, botanical, geographical, geological, meteorological and zoological societies—both national and local amateur bodies—and any other cognate societies which the Advisory Committee may feel should be included. More than three thousand questionnaires have so far been distributed, and it is hoped that any clubs or societies coming within the above terms of reference that have not yet received one will write to the editor, Dr. Averil Lysaght, c/o Bird Room, British Museum (Natural History), Cromwell Road, London, S.W.7.

Scientific and Technical Man-power in Britain

MR. H. NICHOLLS, Parliamentary Secretary to the Ministry of Works, replied on behalf of the Lord President of the Council to questions in the House of Commons on February 25 on the sections on research and development in the annual report for 1956–57 of the Advisory Council for Scientific Policy. He said that the Government is playing its part by approving the expansion programme for universities and technical colleges. It is for industry to take full advantage of the skill made available for civil research by the limitation of the defence programme. The Advisory Council is now studying in greater detail the methods of financing research at universities, including the provision of supporting staff. There is no sign at all of serious redundancy. Professional scientific and engineering institutions have offered to co-operate with the Committee on Scientific Man-power in carrying out an annual review of their membership, and in addition it has now been decided to undertake, towards the end of 1958, a further survey of the number of scientists and engineers in Great Britain, similar in scope to that made in 1955. He did not think there is anything to substantiate the suggestion that industry does not keep in close touch with new research in Britain and elsewhere.

Smoke Abatement

MR. H. NICHOLLS, Parliamentary Secretary to the Ministry of Works, replying on behalf of the Lord President of the Council to a question in the House of Commons on March 4 regarding research on the measurement and reduction of smoke from industrial chimneys, said that the Fuel Research Station of the Department of Scientific and Industrial Research had developed two types of instrument to simplify the measurement of smoke. One is intended to show a stoker in the boiler house, and the other a smoke inspector outside, when smoke darker than the legal limit is being produced. The Research Station has also developed smoke-eliminating devices for industrial hand-fired boilers, adoption of which would offer a saving of more than 1 million tons of coal a year.

Emergency Supplies of Water

IN moving the second reading of the Water Bill in the House of Lords on February 27, the Minister without Portfolio, Lord Mancroft, said that the measure, which was designed to give permanent powers for maintaining public water supplies in serious droughts, would enable us to dispense with Defence Regulation 50*A*, under which orders had been made allowing water undertakings to draw water from emergency sources, and Defence Regulation 56, which had been used to relax restrictions and obligations resting on water undertakings. In the past few years a dozen or more water undertakings have been amalgamated and other discussions are proceeding. Although there are still nearly 1,000 such undertakings, he did not agree that nationalization is the best way to make them efficient; nearly 700 are actively considering amalgamation or re-grouping, and more than £240 million had been spent since the War on water supplies in Britain. Lord Mancroft said that the Bill broadly followed the lines of the Water Supplies (Emergency Shortage Orders) Act of 1934, Clause 1 allowing the Minister of Housing and Local Government or the Secretary of State for Scotland, if either is satisfied that a shortage of water supplies exists or is threatened because of an exceptional drought, to make orders authorizing undertakings to draw water from a source not normally used and to vary restrictions or obligations resting on the undertakings as to the amount of water that may be

pumped from a river or the amount of compensating water to be discharged from their reservoirs. The Ministers are required to consider the interests of all concerned with the conservation or use of the water for agriculture, fisheries, industry, navigation, etc. Comparatively little potable water is used by the Atomic Energy Authority.

Committee for Biological Acoustics

In 1956 an International Committee for Biological Acoustics was set up at a conference in the United States to act as a focus for research on human and animal acoustics. The growing interest in this field in Great Britain has created a demand for a national committee, which has now come into being. Its constitution is as follows: *Chairman*, Prof. R. J. Pumphrey, Department of Zoology, University of Liverpool (who is also the British representative on the International Committee); *Secretary*, Dr. P. T. Haskell, Anti-Locust Research Centre, London; *Members*, Dr. E. C. Cherry, Department of Electrical Engineering, and Mr. D. Leston, Department of Zoology, Imperial College of Science and Technology, London; Dr. F. C. Fraser, Department of Zoology and Dr. D. R. Ragge, Department of Entomology, British Museum (Natural History); Dr. L. Harrison-Matthews, Zoological Society of London; Dr. J. W. S. Pringle, and Dr. W. H. Thorpe, Department of Zoology, University of Cambridge.

The committee hopes to arrange meetings on biological acoustics in collaboration with established biological societies, will maintain close liaison with the International Committee, and is also investigating the possibility of setting up a British collection of recorded animal sounds. A necessary first step will be to ascertain the present extent of interest in and the range of research on biological acoustics in Britain, and it is proposed to compile a list of all those interested in the field. Anyone interested in any aspect of human or animal acoustics should send his name and address, with brief comments on his research and field of interest, to Dr. P. T. Haskell, Anti-Locust Research Centre, 1 Princes Gate, London, S.W.7.

The Egyptian Journal of Geology

In these days when the output of scientific literature challenges the ability of the worker in even the most specialized fields to keep himself informed about current research, news of the publication of yet another scientific journal must sometimes be received with mixed feelings. This will not, however, prevent geologists from wishing success to the Geological Society of Egypt, which in 1957 published the first number of the *Egyptian Journal of Geology*, which is to be produced in future twice-yearly. Egypt is a country of considerable mineral wealth and with many features of geological interest; the new *Journal* will provide a useful forum for her geologists, and it is good that the results of their work should be made readily available to the scientific world at large. In the current issue, three of the four articles are concerned with specifically Egyptian problems of stratigraphy, micropalæontology, and mineral resources; the fourth deals with the more general subject of the serial character of igneous rocks. The articles are printed in English with Arabic summaries in this issue, but the editors invite contributions written in any language employing Latin or Arabic characters. An otherwise excellent format is marred by the adoption of a tall, narrow type-face which gives an impression of elegance but is trying to read. The *Journal* is published at Tager Building, Elhami Street, Kasr El Doubara, Cairo, and costs 50 P.T. (10*s*.).

Current Research on Orthoptera

The number of workers now engaged in research on Orthoptera is large and the field of work is very extensive, often resulting in unnecessary duplication of work and in restriction of exchange of ideas. A questionnaire was sent out by the Anti-Locust Research Centre, London, in 1956 to institutions and scientists all over the world known to be engaged in research on Orthoptera, asking them to provide information on the subjects of their research. Of 250 questionnaires sent out, 215 were returned by workers in thirty-seven different countries. As a result, a list of workers and their addresses, indicating the nature of their current work, has been issued by the Anti-Locust Research Centre, under the title "Current Research on Orthoptera", for circulation among all those known to be engaged in research on Orthoptera. The fields of research covered have been divided into seven sections (the figures in brackets showing the number of projects listed in each case) as follows: taxonomy and faunistics (51); anatomy and morphology (26); physiology (biochemistry and metabolism) (37); physiology (nervous system and sense organs) (21); behaviour (46); ecology, biogeography and general biology (76); and pest control (35). When a scientist is engaged in research related to more than one section, separate cross-indexed entries have been made, so that any one section contains a complete list of all known workers in that field. The arrangement within each section is alphabetical. All those listed will receive "Current Research on Orthoptera", further numbers of which will be issued as new or revised entries accumulate. All inquiries and any information for inclusion in the list should be addressed to the Anti-Locust Research Centre, 1 Princes Gate, London, S.W.7.

Swedish Forest Research

Scots pine (*Pinus silvestris*) and Norway spruce (*Picea abies*) form the chief commercial species of the Swedish forests and source of annual revenue obtained from them; it is to be expected, therefore, that these species should be considerably studied in the Forest Research Institute at Stockholm. In the report of the Forest Research Institute of Sweden (Vol. 46. Pp. 572. Stockholm: Statens Skogsforskningsinstitut, 1957) two interesting papers are printed: "Germination Analyses by the X-ray Method of *Picea abies*" and "Seed Development of *Picea abies* and *Pinus silvestris*". The X-ray experiments on the spruce here described are a continuation of work previously carried out at the Institute. The method of predicting the germinative properties of a seed from its X-ray photograph is based on the close correlation between these properties and the morphological characteristics of the seed's embryo and endosperm. The seed was harvested with great care, mostly from northern localities where the less developed seed types are found more frequently. The paper gives full details of the methods employed, with photographs. In the second paper, on the seed development of the two species, the aim of the investigation was to establish the time of fertilization and to follow embryo development during summer and early autumn. The material was collected from trees growing in the vicinity of Stockholm. The

report gives data on the time between pollination, fertilization and other interesting facts. It is illustrated with good photographs.

Carlsberg–Wellcome Travelling Research Fellowships, 1958–59

THE directors of the Carlsberg Foundation, in Copenhagen, and the Wellcome Trustees, in London, instituted in 1957 a system of Carlsberg–Wellcome Travelling Research Fellowships, with the object of encouraging friendly co-operation, on an exchange basis, between Danish and British research workers in any branch of the natural sciences which has a bearing upon human and animal medicine. One Fellowship annually is awarded to a candidate from the United Kingdom for a year's work in Denmark and one annually to a Danish candidate for a year's work in the United Kingdom. The stipend may range from £800 to £1,200 per annum (or the equivalent sums in Danish kroner) for whole-time research. Travelling and some incidental expenses are provided in addition. It is intended to make the second two appointments in respect of the academic year beginning September 1958. Inquiries from candidates in the United Kingdom should be addressed to the Scientific Secretary of the Wellcome Trust, 52 Queen Anne Street, London, W.1, from whom further particulars can be obtained. There is no form of application, but candidates should submit a full *curriculum vitae*, together with details of their research proposals and a supporting letter from a senior scientist who is familiar with their work. Completed applications must be submitted before April 30.

Physical Society Handbook of Scientific Instruments and Apparatus

THE annual exhibition of scientific instruments and apparatus of the Physical Society, to be held in the Halls of the Royal Horticultural Society, London, during March 24–27 (see *Nature* of March 8, p. 673) is an established feature of the scientific year in London. The "Handbook of Scientific Instruments and Apparatus, 1958 Exhibition", published in connexion with the exhibition (pp. xvi+284+pp. 84 advertisements. London: The Physical Society, 1958. 6*s*. net), is not only a detailed catalogue of, and guide to, the exhibits, but also a valuable work of reference on recent developments in the design of physical apparatus, providing, moreover, convenient lists of British manufacturers, and of recent scientific and technical books. The "Handbook" is arranged in numerical order of stands at the exhibition and includes a brief description of every item. There are comprehensive indexes both of exhibitors and of all subjects exhibited, and the large section devoted to advertising is in itself a valuable collection of useful information.

Physics in Schools

A JOINT Easter conference of the Education Group and the South Western Branch of the Institute of Physics on "Physics in Schools" is to be held in the H. H. Wills Physics Laboratory of the University of Bristol during April 9–11. The conference will be opened by Sir Philip Morris and addressed by: Mr. A. D. C. Peterson (director of education, City of Oxford) on general education and physics in the sixth form; Mr. D. W. Scott (University of Bristol) on teaching physics in middle and upper forms of grammar schools; Mrs. C. E. Arregger (Hilger and Watts, Ltd.) on the problem of recruiting women as physicists; Mr. W. Llowarch (Institute of Education, London) on the role of practical work in the education of a physicist; Prof. C. H. Dobinson (Reading) on the General Certificate of Education examinations at Ordinary and Advanced levels for future physicists; Prof. G. K. T. Conn (Exeter) on the transition from school to university; and by Dr. J. Topping (principal of Brunel College of Technology, London) on the education of physicists in technical colleges. The conference is open to all who are interested, and accommodation will be available in Wills Hall. Further details and forms of application to attend can be obtained from the Institute of Physics, 47 Belgrave Square, London, S.W.1.

Announcements

THE annual Conference of Science for Peace will be held on March 22 at the Mahatma Gandhi Hall, Fitzroy Square, London, at 2 p.m. Speakers will include Prof. S. C. Harland, Dr. R. L. M. Synge and Dr. E. H. S. Burhop.

SIR HANS KREBS, Whitley professor of biochemistry in the University of Oxford, has been awarded the Gold Medal of the Association for the Advancement of Natural, Medical and Surgical Sciences, Amsterdam, for outstanding scientific achievement. This Medal was instituted in 1840, and the first awards in 1865 were to medical men; later recipients have included Lorentz, van der Waals, Kamerlingh Onnes, Einstein and Sir Henry Dale.

THE Mechanical Engineering Research Laboratory of the Department of Scientific and Industrial Research, East Kilbride, Glasgow, is to hold open days on June 4 and 5. Applications for invitations on either day from representatives of any organization with engineering interests should be sent to the Director.

THE Cornell Summer Laboratory Course in Techniques and Applications of the Electron Microscope for senior workers in the biological and medical sciences is to be given during June 16–July 3 and is being supported by a grant from the National Science Foundation. The course, which is primarily for scientists using the electron microscope in their research work, is under the direction of Prof. B. M. Siegel, to whom all inquiries should be addressed at Rockefeller Hall, Cornell University, Ithaca, New York.

THE scope of the annual Conference on Conservation of Nature in south-east England, which is to be held in the Zoological Society, Regent's Park, London, N.W.1, on April 12, has been extended to include all societies in south-eastern England whether they are members of the South-Eastern Union of Scientific Societies or not. The chair will be taken by the Earl of Cranbrook, and the following addresses will be given: "The Invertebrate Fauna of Chalk Country and its Conservation", by John Sankey; "The Vertebrates of Frensham Ponds and Romney Marsh", by Maxwell Knight; "Possible Nature Reserves in Kent, Sussex and Surrey from a Botanical Ecologist's Viewpoint", by Dr. Francis Rose; and "Conservation in Hertfordshire", by Dr. J. T. Dony. A symposium on the contribution of naturalists' trusts to Nature conservation will also be held. Further details can be obtained from the secretary of the South-Eastern Union of Scientific Societies, Mr. F. Edwards, 53 The Drive, Shoreham-by-Sea, Sussex.

AGEING AND EMPLOYMENT

THERE are many general statements and assumptions about the employment of older workers in industry, but few facts to support those assumptions. An inquiry* carried out by F. Le Gros Clark into the effects of ageing on 251 manual workers in the furniture industry provides information which will, therefore, not only be useful for employers in that industry, but also in other kinds of manufacturing industry.

Most domestic furniture is produced in large factories, which are tending to increase in size and are achieving greater efficiency mainly through the detailed planning and simplification of a large number of successive hand-and-machine operations. Many of the men employed are no longer craftsmen in the traditional sense of that word; they have each been trained on the job to carry out a limited range of operations. Since comparatively few of the men in the mechanized furniture industry are all-round craftsmen, their chances in later life depend partly upon their own adaptability as operatives or labourers, and partly upon the degree of ingenuity and forbearance shown by shop supervisors and foremen in fitting the job to the man.

In consultation with shop supervisors and others, Le Gros Clark examined the industrial and medical records of 251 men whose ages ranged from 55 to 76; they all worked in large factories. They were still employed or had, in a few cases, recently retired. Men were not compulsorily retired at a certain age.

Of the seventy-three men aged from 60 to 64, sixteen had been transferred permanently to jobs of a light character; practically all of them were labourers. Ten other men were only able to remain at or 'near' their normal jobs after some concessions and adjustments had been made. The remaining forty-seven men were still working in the ways to which they had been accustomed for some years past.

An ailing or ageing labourer may be less easy to accommodate than an operative in the same physical condition. He has frequently to be found light labouring work; and that is usually a matter of searching for a job that he can be trusted to carry out at his own pace. The jobs that were found had to be free from the characteristics that had disqualified the labourer from his normal work.

On the other hand, the ten men, for whom some allowances on the job had clearly been made, were mostly operatives. They had not been transferred from their normal departments and some pains had been taken to adjust the work to their physical capacities. The adjustments made often followed on a medical recommendation. A cabinet-maker, for example, had, until the age of 59, been assembling heavy wardrobes; after a hernia operation he had been transferred to light drawer assembly, where he could still, at 63 years, maintain a good pace of output. There was clear evidence of the firm's flexibility in handling older men once deterioration in their health had been checked and their physical condition fairly well stabilized.

Of the forty-seven men still on their normal jobs, Le Gros Clark believed that about one in four were not maintaining the level of output which they had once been capable; these men, too, would have needed some tolerance on the part of their supervisors. At a liberal estimate it appeared that about three in ten of the men in their early sixties were permanently incapacitated for full normal duty; in the case of several others some allowances had to be made.

There was little evidence that men were retiring or even contemplating retirement at the age of 65. Forty-two of the men between the ages of 65 and 69 were traceable from the records. Their patterns of employment were much the same as for those in their early sixties, except that larger numbers of them had to do some light or modified form of work. Sixteen out of these forty-two men (all but one were labourers) had been transferred to light jobs, or else had left their employer in so poor a physical condition that they could scarcely have undertaken any but the lightest work. No long-service employee among them had been discharged on an employer's initiative. Five of the sixteen men were bronchitic; the rest had records of arthritis, hypertension and cardiac debility. When an elderly man had no serious ailment of this nature, it was usually possible to maintain him on his customary work with minor concessions. Another twelve of the forty-two men, mostly operatives, had been provided with work of a distinctly modified kind.

Sixteen men in the records were aged 70 and over. Ten of these had little indication of sickness in their records. This is a common experience throughout industry; such old workers are doubtless in many industries no more than the constitutionally sound survivors of a diminishing generation. Their age had been allowed for in the ordering of their work. In no case was a man in his seventies in full production on what once had been his accustomed job. Each was employed now on very modified or easy-going operations or on tasks of a distinctly light character. Probably not one of these elderly men would have been physically capable of much further work when he did at last retire.

The inquiry clearly showed that some older men in the industry (though not necessarily in other industries) have often to give up their full normal work at about 60. Thenceforth, they only remain employable in furniture production to the extent to which readjustments and transfers can be arranged for their benefit on the shop floor.

In mechanized production of domestic furniture the overall tempo, though it does not necessarily force the pace of a man's individual movements, has to be maintained at a high level. This could easily discriminate against an employee who is ailing or slowing down. By the time they reach their mid-sixties, between one and two out of every five of the men would probably have had to be moved to light operations or to light labouring jobs. By the time they were in the seventies the proportion would be much higher. Similar figures are common in other industries.

In furniture production the continued employability of ageing men depends on two factors. How far are shop supervisors able to break down and reorganize operations in the interests of ageing or

* Ageing on the Factory Floor. By F. Le Gros Clark. (Studies of Ageing within the Conditions of Modern Industry.) Pp. 36. (London: The Nuffield Foundation, 1957.)

ailing men? And what reserves of skill and adaptability have the ageing men themselves? In an industry of this kind it becomes difficult to employ an elderly operative or labourer in the production line, unless he has reserves of adaptability to fall back on. This often depended upon whether these partly skilled men have acquired sufficient craft experience to make them still employable at their age. The craft background of many of the older men has given them assurance of employment. Though a good many of them may have been employed for most of their lives on repetitive and machine work, their early training with hand tools would have sufficed to fit them for transferring at some stage to the finishing shop, repairs or jig-making, according to their degree of skill.

Against this, where operatives now in their middle lives have not been trained in craftsmanship but only for machine and assembly operations, in later years they may prove somewhat of a problem. Not only will there probably be large numbers of them; they will lack the craft training that would have made them adaptable old employees.

Of the furniture industry as a whole, Le Gros Clark suggests that it will still continue to experiment with new techniques and with new and more efficient factory organization. That, inevitably, means concentration and division of labour; and in a factory where the timing of a large number of successive and converging operations is of paramount importance, it becomes difficult to allow too many operatives to fall too far below a standard level of output. A factory that has incurred heavy overhead charges in the employment of technical and other experts will have streamlined production processes to such an extent that it has to maintain a labour force that is physically capable of the effort and continuity needed. In other words, it has less flexibility than had an old-time workshop in employing its own ailing or ageing operatives.

FUEL CONSUMPTION AND RESOURCES

ONE of the four main purposes of the Clean Air Act is to prohibit in Britain the emission of dark smoke from chimneys, and on February 6 the Minister of Housing and Local Government, Mr. H. Brooke, announced that from June 1 emission of such smoke will be liable to incur a fine of up to £100. This will apply to factories, shops, offices and the funnels of ships and railway engines as well as to domestic chimneys, and from that date all new furnaces installed for burning pulverized fuel, or more than one ton an hour of other solid fuels, must be equipped with grit- and dust-arresting plant approved by the local authority.

These regulations will be applied through statutory instrument No. 167 (*C*2) of 1958, which was laid before Parliament on February 6 and appoints June 1 as the day for the operation of all those provisions of the Clean Air Act which were not brought into force by statutory instrument No. 2022 (*C*19) of 1956. It would seem, however, that much still remains to be done in the way of educating both the public and the local authorities on the importance and benefits of smoke control. In replying to a question in a broadcast discussion the following evening, a group of speakers, which included a member of Parliament, showed a regrettable lack of public responsibility and even ignorance of the fact that domestic fires rarely emit dark smoke as defined in the Act—"as dark as, or darker than, shade two on the Ringelmann chart".

Some reference was made to the importance of smoke abatement in a debate in the House of Lords on February 5. Lord Macdonald of Gwaenysgor, who opened the debate, referred to the importance of the most efficient use of coal and the need for adequate independent scientific advice: he was concerned that this should be available to the Minister of Fuel and Power. Lord Stonehaven, who stressed the value of the National Industrial Fuel Efficiency Service, referred to the savings to be achieved by scrapping the obsolete and inefficient Lancashire boilers still in use, the importance of adequate instrumentation and of competent stokers. Lord de L'Isle insisted that adequate provision for storing fuel is essential if fuel is to be handled economically for central heating systems. Lord Teviot and Lord Hall both referred to the contribution of science to the efficient use of fuel and power resources, but the major interest of the debate centred in the review of these resources which Lord Mills, the Minister of Power, gave in his reply.

Lord Mills suggested that we are approaching a turning-point in that field. Coal is still the foundation of British fuel economy, but while its consumption has increased by 10 per cent since 1948, that of oil has increased by 91 per cent. There is also a tendency for an increasing proportion of fuel to be consumed in refined forms: since 1948, coke consumption has increased by 15 per cent, gas by 27 per cent and electricity by 99 per cent, so that they now account for 40 per cent or more of inland consumption, compared with 25 per cent before the War. Taking all fuels together, 60 per cent is consumed by industry, 13 per cent by transport and 27 per cent by the domestic consumer. Half our coal supplies go to making fuel or energy, 18 per cent to the domestic consumer, 6 per cent to transport and 26 per cent to industry and commerce, which consumed 60 per cent of electricity supply and more than half that of gas.

Lord Mills said that planning must be based on the assumption that the inland demand for coal will continue to grow, but more slowly than that of other primary fuels. Its direct use by the railways and householders will decrease, but there may be large increases in the demand for coal by coke ovens. As regards small coal, stocks amount to 6 million tons, mainly from deep mines, although two-thirds of open-cast coal is in that form, compared with half of the deep-mined coal. Demand for oil is likely to continue, but the power station oil-conversion programme has been reduced by one-third, to the equivalent of 6 million tons of coal. The advent of nuclear power as a third fuel, however, has brought us to the turning point. Nevertheless, nuclear power at present represents very big demands on capital

resources and the Minister thought it is entirely right to retard the programme slightly, making up the difference by conventional power stations.

In reply to questions about ZETA, Lord Mills said that while the production of a thermonuclear reaction under controlled conditions has been demonstrated as a practical possibility, the stage reached is comparable with that attained in 1938 when it was first demonstrated that if the atom could be split energy would thereby be released. It took eighteen years to produce the Calder Hall station, which was the prototype of the nuclear power programme, and the problems associated with the controlled release of thermonuclear power are certainly no less formidable. The Government will ensure that full account is taken of all the potentialities opened up by the genius of our scientists and technologists but, even on the most optimistic assumption, it is scarcely conceivable that the present programme for nuclear power will need modification because of these further developments. Lord Mills also suggested that the availability of nuclear power and the removal of the pressure of demand for coal will enable the coal industry to be more selective in its output, both in terms of cost of production and of the kinds of coal produced. He agreed as to the importance of efficiency in consumption and professed himself satisfied with the arrangements for scientific advice. He is setting up a committee to consider improving co-operation between the Area Electricity and Gas Boards, and a pilot plant for underground gasification is under construction.

LIBRARIES

EAST met West at the one-day conference of the Scottish Branch of Aslib in the Scottish Central Library, Edinburgh, on February 7. Five speakers representing overseas countries, but all working in Great Britain, gave papers on different aspects of library and information work in Britain and in their own countries.

Miss Margaret Haferd, Librarian of the U.S. Information Service Library in London, spoke of the different useful services that her establishment could offer by way of information on work in America, and technical books.

The principal speaker of the meeting was Dr. J. C. Malloch, of the Scientific Liaison Office of the National Research Council of Canada. His paper was on "Technical Information in the Modern World". He pointed out how science and technology affect every aspect of daily life, food, clothing, and travel. Even the classicist often does not realize the absurdity of voicing his scorn of science on television and reads Thucydides more easily because a technologist has developed a better printer's ink.

Dr. Malloch suggested that to get the type of general education that is needed, schools and teachers must have available the basic technical information in the right form. He criticized the old dull text teaching Boyle's law, the valency of oxygen or the bones of a frog to students, many of whom will never need this information. He suggested it should be replaced by material which would convey the fascination of scientific discovery and a realization that it really means something to every individual, whatever walk of life they might choose. This is a challenge that cannot be ignored if science is to have the intelligent public support necessary to its development and proper use.

He next spoke about abstracting services, and the tremendous expansion of scientific work in the past twenty years, much of which never appeared in standard journals, and how it had materially altered the situation. While chemists and physicists were served by abstract journals, biologists were badly off. By their own figures, the coverage of *Biological Abstracts* is only about 40 per cent and the publications of the Commonwealth Agricultural Bureaux cover only special fields, generally selectively. The industrial fields of applied science and engineering are virtually without abstracting services. We are now realizing the vast amount of important scientific and technical information that is available in the U.S.S.R., its satellites and China which is scarcely touched by most of the abstracting services and only available with difficulty in any form.

Scientists need help and this is a suitable task for information services, but one which must be carried out by methods agreeable to the working scientists. Many research organizations now make use of public relations or press officers whose duty it is to make known the activities of the laboratories and to present the results to the general public in an understandable form. Discoveries of science only become of immediate importance to mankind when they are available for the general benefit. As a result of nearly fifteen years of experience Dr. Malloch believes that the personal approach of field-officers throughout the country is the best method of disseminating information to factories and industry. Dr. Malloch suggested the motto of a public relations officer of the National Research Council in Canada might well be adopted: "No sooner done than said".

Dr. Malloch then went on to describe in detail the work of the National Research Council of Canada. Its library is the major scientific library of Canada and is operated as a national service. It maintains an index of all the translations made of scientific papers in Canada and co-operates with the Commonwealth Index of Translations.

The afternoon session was devoted to papers on library work in their own countries by three ladies at present working in Edinburgh and Aberdeen libraries. Miss L. Somme, of Hammerfest, Norway, at present in Edinburgh, gave the picture of the growth of libraries in her country since the Second World War. Interest in reading had begun during the war when there was little else to do. Now each county had a main district library and attempts were being made to cover outlying districts by mobile libraries by road and sea. The purchasing and binding of books are carried out by the State. Librarians have a three-year course and, as there is a great lack of librarians, positions are easy to obtain.

Miss T. Visser from Utrecht said that in Holland, owing to religious beliefs, it was quite common to find in any one town three public libraries, one neutral, one Roman Catholic and one Calvinistic,

each getting State grants. All, however, are members of the Central Association of Public Libraries, which is responsible for the training and placing of librarians. Special libraries were late in commencing and are now organized by the Netherlands Institute for Documentation and Organization of Libraries. A very useful tool for Dutch librarians is the Union List of Periodicals held in the 166 libraries in the Netherlands maintained by the Royal Library at the Hague.

Miss De Silva, at present in Aberdeen, spoke of the differences between the libraries in Ceylon, Kenya and the United Kingdom. She pointed out that the two eastern countries were backward and not well equipped. Both countries were similar in basing their libraries upon British methods and Ceylon was the more advanced. There are three libraries in Kenya, the Macmillan Library for Europeans, one for Africans only and one general. J. R. K. PIRIE

EXOTIC FOREST TREES IN GREAT BRITAIN

IT is held that Great Britain contains a larger number of exotic trees than any other country, some of which have been well known for a long time. These have adapted themselves to soils and climate so well that they are regarded as indigenous species. This abundance conceals our poverty of native trees, especially conifers, among which the only natives are the Scots pine, the yew and the juniper, the latter little more than a straggling bush. Among broad-leaved trees the difference is not so great, but even in this group familiar trees such as the sycamore, the horse chestnut and the plane have been introduced in historic times. The sycamore is notable for its rapid growth in youth, for the lovely tree produced and its great fertility, young seedlings springing profusely from the seed shed in most years.

The Forestry Commission has recently published Bulletin No. 30 on "Exotic Trees in Great Britain", prepared by Messrs. James Macdonald, R. F. Wood, M. V. Edwards and J. R. Aldhous for the British Commonwealth Conference held last July in Australia and New Zealand (H.M. Stationery Office, 1957). The Scots pine formed forests in the Highlands of Scotland, but the Norway spruce, now so common in Britain, was absent. The beech was native only in the south of England and absent from the deciduous forest dominated by oak in the rest of the country. This is in marked contrast with France, where the great oak and beech forests are the glory of that country. Part 1 deals with general considerations affecting exotic forest trees in Great Britain; Part 2 exotic coniferous trees; and Part 3 exotic broad-leaved trees in Great Britain.

The poverty of the tree flora of the British Isles is attributed partly to geographical situation and partly to recent geological history. The introduction of exotic species was at first due to individuals who brought them in for æsthetic purposes on their estates. More recently, commercial motives have increased the rate of introduction of some species such as the sitka spruce and Douglas fir from North America and the Japanese larch. The European larch came in much earlier and was planted on private estates, but the Norway spruce and the silver fir were imported during the past two centuries.

The sitka spruce has been largely used in the twentieth century by the Forestry Commission in planting the new forests of Britain, as have the Japanese larch and the Corsican pine. Thirty-eight genera of conifers and twenty-two genera of broad-leaved trees have been introduced into Britain.

EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

REPORT FOR 1956

THE second annual report of the European Organization for Nuclear Research (CERN), covering the period to the end of 1956*, is—as Prof. C. J. Bakker, the director-general of the Organization, remarks in his brief introduction—a straightforward account of development during the year, which indicates that rapid progress has been made in accordance with the plan outlined in the previous annual report (*Nature*, 178, 902; 1956). However, several years of intensive scientific and technical work still lie ahead before Europe's great joint laboratory for advanced nuclear research can begin to operate fully. Except for the high-frequency system the synchro-cyclotron was practically completed; it was expected to come into operation during 1957. The buildings for the proton synchrotron were also nearly finished and orders for most of the components of the accelerator have been placed. The many illustrations and photographs given in the annual report show clearly the remarkable progress made in the construction of these two large accelerators and their associated buildings, and much detail of the layout and characteristics of the machines is also given in the two sections of the report devoted specially to them.

The purpose of the two-week symposium on high-energy accelerators and pion physics, organized by CERN and held in Geneva during June 1956, was to gather physicists from all over the world and thus enable the Organization to start playing the part for which it was intended as an international centre of advanced studies. 319 scientists from twenty-two countries, including some fifty American and an equal number of Russian scientists, attended. Most of the papers presented had been pre-printed either in English or French and were circulated before the conference. The discussions were recorded, and the proceedings were afterwards published in full in two volumes (see *Nature*, 179, 283; 1957). It is proposed to hold a similar symposium in 1958. During the first week the principles and methods used in the con-

* Second Annual Report of the European Organization for Nuclear Research (CERN), 1956. Pp. vi+71 (19 plates). (Geneva: European Organization for Nuclear Research, 1957.)

struction of high-energy accelerators were discussed, and during the second week particle-detecting equipment and high-energy nuclear experimental research with special reference to pion physics. The section of the annual report describing the symposium includes a summary of the main contributions and of the new advances in research discussed, and a list of the titles of the papers which were presented by members of the staff of the Organization is given in an appendix.

No major change in the internal structure of the Organization took place during 1956. Theoretical work was carried out both under the direct control of Prof. Bakker at Geneva on cosmic rays and in the Theoretical Study Division at Copenhagen; the other five Divisions consisted of the Proton Synchrotron, Synchro-Cyclotron, Scientific and Technical Services, Site and Buildings, and Administration. The number of the staff increased from 260 to 396, and in addition there were eight half-time workers, fourteen consultants and twenty-two Fellows. Thirty-one scientific articles were published and a very large number of lectures and colloquia, all of which are listed in the annual report, were arranged.

In the field of equipment the set of two cloud chambers was successfully completed by the Scientific and Technical Services Division and will be used for experiments on K-mesons. The Division has been studying the techniques of production and handling of liquid hydrogen and liquid helium for low-temperature work, and a liquid-hydrogen plant with a capacity of 20–40 litres/hr. is being built. An experimental liquid-hydrogen bubble chamber, 10 cm. in diameter, and later a larger chamber, 30 cm. in diameter, are to be constructed. Following Harwell and Saclay, and with a view of establishing interchangeable methods and means of computation with these two establishments, the Organization has ordered a 'Mercury' electronic computer, and an experienced mathematician-physicist has been recruited to direct the Computer Section of the Division. In addition, two engineers of the Division spent four months with the electronic groups at Harwell and Saclay.

EMBRYOLOGY OF POGONOPHORA AND CLASSIFICATIONS OF ANIMALS

By Dr. S. M. MANTON, F.R.S.
Department of Zoology, King's College, London, W.C.2

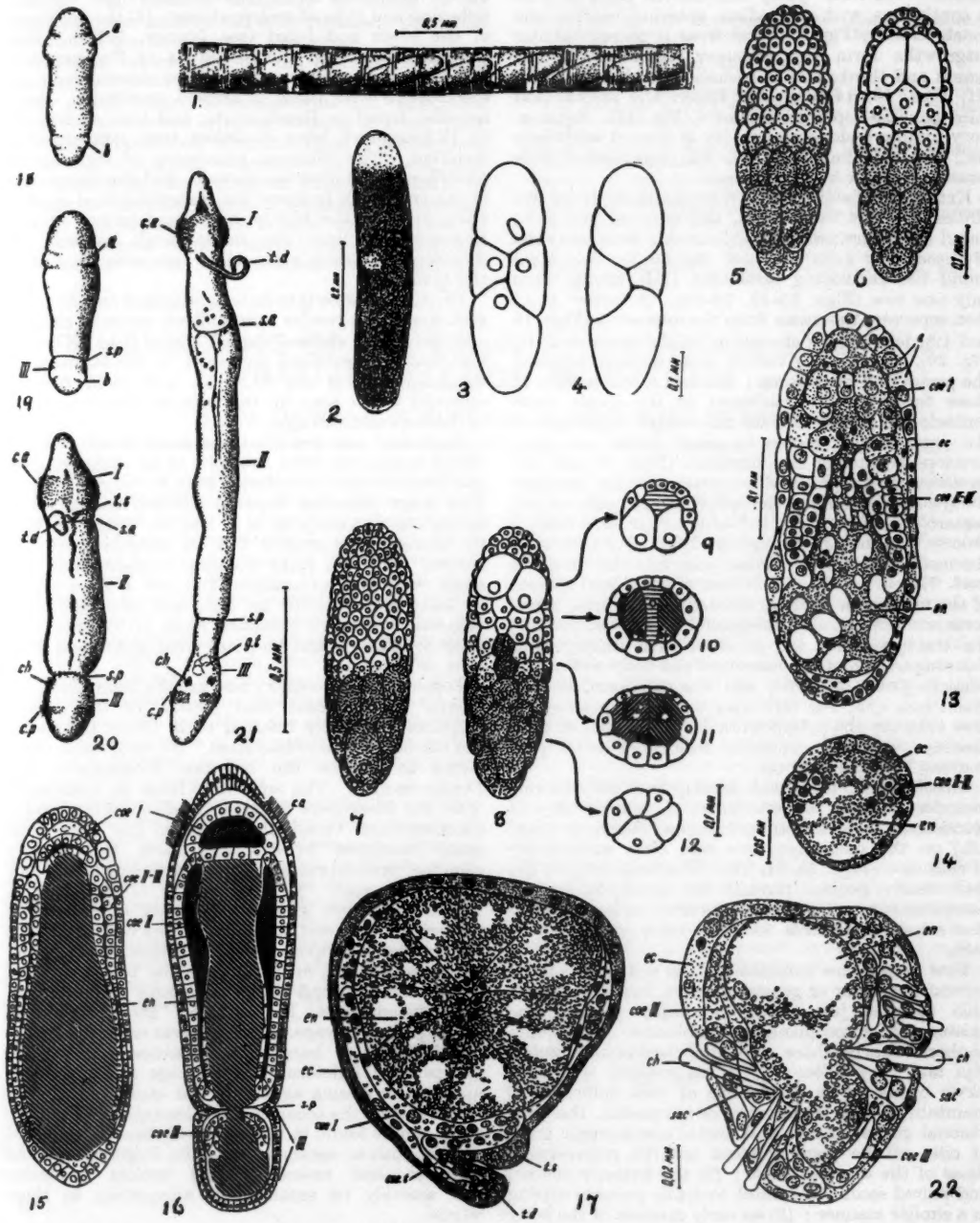
THE past twenty years have considerably widened zoological conceptions concerning the types of animals which are phylogenetically associated with the echinoderm-chordate stem. Kozlowski[1] (1938, 1947) dissolved the matrix from certain graptolites and cleared them, so demonstrating a similarity in budding and tube structure to *Rhabdopleura*, thus suggesting a protochordate rather than a coelenterate affinity for this great group of fossil animals (see also Bulman[2]). At that time much had been found out concerning evolution within the graptolites, but no clear evidence had been obtained as to the grade of organization of their soft parts, so that their systematic position was obscure. The class Pogonophora was described in 1937 by Johansson[3]. But it was the anatomical work of Ivanov in the University of Leningrad[4], on two orders of Pogonophora, collected from deep water in the north-west Pacific, which provided a sufficiency of detail both to demonstrate their place in the animal kingdom near to the Enteropneusta, and to show the extraordinary occurrence of extracellular digestion and absence of a gut in a non-parasitic triploblastic animal.

Recently, Ivanov[5] has given embryological details of a certain number of developmental stages of Pogonophora from the Okhotsk Sea, the preservation of which has been sufficiently good for sectioning. He stresses the incompleteness of the series and imperfections of fixation; but his results are of such interest that a summary is given below, together with reproductions of some of the figures. Reference must be made to the original publication in Russian for further details.

About 32 batches of eggs, mainly of *Siboglinum caulleryi*, have been studied. The eggs in each batch, up to 42 in number, lie in a row inside the parental tube distal to the head of the mother (Fig. 1), where they undergo most of their development. No free-swimming larvæ are formed. The bilaterally symmetrical egg, much elongated in *Siboglinum*, is heavily yolked; the nucleus (Fig. 2) lies nearest to the concave side of the egg. The darker distal pole of the egg gives rise to the anterior end, and the more yolky proximal pole to the posterior end of the young adult. Fertilization is presumed to take place in the tube. The nucleus migrates to the distal end of the egg, and after fertilization returns to the middle region; the egg then becomes invested by a soft vitelline membrane. Development within each clutch is synchronous.

Cleavage is total, unequal and appears to be 'determinate'. There is no trace of either the spiral or typically radial type of cleavage, and the unique pattern appears to be anything but primitive. The egg shortens and divides diagonally, and unequal cleavages beyond the 4-celled stage are not synchronous (Figs. 3 and 4). Bilateral symmetry is marked at the 80–85 celled stage, large cells lie at the posterior end and on the convex side, and two very large cells are situated towards the anterior end on this side (Figs. 5 and 6, same embryo).

By the 130- to 140-celled stage internal cells are established, presumably by delamination or by overgrowth. Three large endodermal cells, one extending in front of the other two, fill most of the interior of the embryo, and contain the bulk of the yolk (ruled in three different directions in Figs. 9–11). Two surface cells rich in yolk lie in the middle of the convex side (dark in Fig. 8). In addition, two small groups of cells, presumed to be mesenchyme, are situated as shown in Fig. 10. The posterior outer cells are rich in yolk, and the large pair of anterior cells (Figs. 8 and 9, same embryo) remain unchanged for a while; their fate is unknown. This stage represents a gastrula, but a blastopore is not formed.



Figs. 1–16 and 18–21, egg and embryos of *Siboglinum caulleryi*; Figs. 17 and 22, sections of *Oligobrachia dogieli*; Figs. 3 and 4, concave and convex sides, respectively, of same embryo; Figs. 5 and 6, concave and convex sides, respectively, of same embryo; Figs. 7 and 8, concave and convex sides, respectively, of same embryo; Figs. 9–12, T.S. of embryo at the levels indicated by arrows; Figs. 13 and 14, L.S. and T.S., respectively, of embryo younger than Fig. 18; Fig. 15, diagrammatic L.S. of slightly younger stage than Fig. 18; Fig. 16, diagrammatic L.S. of same stage as Fig. 19

The next available stage (Fig. 13) shows the establishment of the coelom, by a method very similar to that seen in the enteropneust *Dolichoglossus pusillus*. An inner yolky endodermal mass of cells is continuous with a median anterior enterocoelic pouch (*coel.* 1, Fig. 13), and from it paired tubular outgrowths form the common rudiments of the second and third pairs of coelomic pouches (*coel.* II–III, Figs. 13, 14 and 15). Later, the second and third pouches separate as shown (Fig. 16). A transitory minute endodermal cavity is formed anteriorly (*en.*, Fig. 17) but elsewhere the endodermal cells remain irregular in a solid mass.

Externally the embryo of *Siboglinum* develops two girdles of short dense cilia, the anterior one (*c.a.*) round the future protosoma (I) arising from two rows of ectodermal cells (*a*), and the hinder one (*c.p.*) round the developing metasoma (III) arising from only one row (Figs. 13–16, 18–21). A furrow (*s.p.*) then separates the meta- from the mesosoma (Figs. 16 and 19), followed by elongation of the mesosoma (II, Fig. 20), and another furrow (*s.a.*) appears between the proto- and meso-soma; internal septa develop at these furrows. The rudiment of the single adult tentacle (*t.d.*) protrudes on the ventral right side of the prosoma; a transitory small fellow one (*t.s.*) develops no further in *Siboglinum* (Figs. 17 and 20). In *Oligobrachia* pairs of tentacles develop progressively on either side of the initial ventral pair, on the postero-ventral arms of a U-shaped tentacle base, a process continuing throughout life. Diverticula of the median first coelomic sac pass into the tentacles (*coel.* 1, *coel. t.*, Fig. 17). Part of the dorsal surface of the mesosoma becomes ciliated. Mesosoma, metasoma and tentacle then elongate (Fig. 20), and perhaps the embryo leaves the parental tube shortly after this stage, moving by muscles of the body wall. The ciliated girdles are lost, and the ectoderm, rich in gland cells (*g.t.*, Fig. 21), may be ready to secrete a new tube for the young animal. No mouth or anus develops, and the endoderm disappears as its yolk content becomes used up.

Muscles of the body-wall develop from the coelomic mesoderm below the ectoderm. Several groups of ectodermal cells secrete provisional chitinous setae (*ch.*) on the metasoma, one seta from each group of cells (*sac.*, Figs. 20, 21, 22). The distal ends of the setæ finally project through the ectoderm, but no conspicuous muscles move these setæ, although some fine ectodermal fibrils to their inner ends may be seen.

Few details are available of the ontogeny of the nervous, vascular or genital systems, but the remarkable features just described amply confirm the existence of enteropneust resemblances. The Pogonophora clearly share with *Dolichoglossus kowalevskyi* and *D. pusillus*: (1) a suppression of pelagic larvæ owing to an abundance of yolk sufficient to maintain a long embryonic development, the provisional girdles of cilia and dorsal mesosomatic tract of cilia of the pogonophoran embryo representing those of the tornaria larva; (2) the anterior median and paired second and third coelomic pouches arising in a similar manner; (3) an early division of the body into three regions, the metasoma being small when first differentiated, and elongating later to form the greater part of the adult body, as occurs also in *Amphioxus*. These features place the Pogonophora squarely among the echinoderm–pterobranchiate–protochordate–chordate group of animals, and no question remains of annelic affinity. Their status as an independent phylum is dictated by: (1) the absence of adult alimentary canal, mouth and anus; (2) the presence of tentacles on the prosoma and not on the mesosoma as in *Cephalodiscus*; (3) the distribution and type of coelomoducts; (4) the positions of the brain and heart (see Ivanov, 1955[4]). The provisional setæ on the metasoma of Pogonophora show no exact similarity in either development or associations with those of annelid parapodia. Setæ are also found in Brachiopoda, and here as well as in Pogonophora have doubtless been convergently acquired. The bilateral symmetry of the egg of *Siboglinum*, the cleavage pattern, and the utilization of the endoderm to carry the embryonic food supply only, indicate the highly specialized nature of the Pogonophora, and the single adult tentacle of *Siboglinum* is clearly a secondary specialization within the group.

Dr. A. V. Ivanov is to be congratulated on achieving such important results from difficult material obtainable only from abyssal waters, and it is to be hoped that future expeditions organized by the Institute of Oceanography of the U.S.S.R. will yield further material which may fill the gaps in Ivanov's series of developmental stages.

Jägersten[6] has described one developmental stage (three specimens) from the tube of an undetermined species of *Siboglinum* collected from Norwegian waters. This stage possesses external ciliation and a yolky cavity-less endoderm as in *S. caulleryi* (Figs. 18–20); no tentacles are present but an anterior furrow is shown. Ivanov's fuller account indicates that this stage is in fact an embryo, and not a larva about to leave the tube, or an asexually produced bud. Jägersten's embryo possesses more provisional setæ than *S. caulleryi* and he notes their differences from setæ of annelids.

Ivanov and his countrymen use the term 'Deuterostomia' to designate that section of the animal kingdom frequently referred to in Great Britain as the echinoderm–chordate stem. We need some other terms to replace the outworn Protostomia and Deuterostomia. The anus may have an association with the blastopore in typical echinoderms, protochordates and vertebrates; but so has it in some quite unrelated invertebrates, and the spirally cleaving invertebrates and the arthropods are not all protostomial. The recognition of relationships within these two great assemblages of animals is universally accepted, although it does not rest on the fate of the blastopore. Closely related animals can be quite different in the fate of the blastopore and origin of mouth and anus[7]. Hyman's[8] definitions of these assemblages, Protostomia, "the groups with determinate cleavage, and mesoderm originating from definite cells or bands", and Deuterostomia, "the groups with indeterminate cleavage and mesoderm and coelom arising as entodermal sacs", also do not fit the facts; the occurrence of 'determinate' cleavage alone can be found in very different form in unrelated groups, such as ascidians, annelids, Pogonophora and molluscs, and mesoderm and coelom formation can scarcely be summarized adequately in these words.

The life-history of Pogonophora shows a clear relict of a tornaria type of dipleura larva which has become embryonic. The cilia are no longer locomotory, and must circulate water to some extent between closely packed embryos before they leave the parent. We cannot agree with Hyman in assigning an ancestral status to the dipleura larva for the whole echino-

derm–chordate group of animals. Garstang[9], de Beer[10] and others have discussed the fallacy of regarding larval forms as representing ancestral adults. The tornaria characters appearing in the pogonophoran embryo can only represent the larval features of the ancestors of this group.

As more information on the little-known phyla becomes available it is perhaps remarkable to find so many groups related to echinoderms and vertebrates using the protection of either floating or fixed tubes or tests (Graptolites, Pterobranchia, Pogonophora, Tunicata), or evading competition by burrowing into the substratum (Enteropneuta, Cephalochordata) or retiring to abyssal waters (Pterobranchia, Pogonophora). It appears to have been the evolution of mobile personal armour and effective locomotory mechanisms which have enabled vertebrates and echinoderms to succeed in all manner of open and competitive environments.

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FLUORESCENCE OF THE TOXIN OF *CLOSTRIDIUM BOTULINUM* AND ITS RELATION TO TOXICITY

By Dr. DANIEL A. BOROFF and Dr. JOHN E. FITZGERALD

Divisions of Microbiology and Biophysics, New England Institute for Medical Research, Ridgefield, Connecticut

THE toxins of *Clostridium botulinum* have been studied extensively in recent years, but no special chemical groups or unusual structural characteristics have been demonstrated to account for their extraordinary biological potency[1,2]. We have recently observed that *botulinum* toxin is fluorescent when activated by a specific wave-length in the ultra-violet, and the intensity of the fluorescence is related to the toxicity. Since chemical modification or preparative procedures which diminish the fluorescence also diminish the toxicity, this fluorescent property of the toxin makes possible a new chemical approach to the study of the toxic portion of the molecule. Furthermore, the fluorescence of the toxin can serve as the basis for a physical, *in vitro* method for measuring the toxicity of a preparation.

Type *C* toxin was prepared and purified by methods previously described[3,4]. The final preparation contained 2×10^7 minimum lethal dose mgm. nitrogen assayed by intraperitoneal injection in 20-gm. white mice. Measurements of survival time of 20-gm. white mice injected intravenously with 0·1 ml. of serial dilution of toxin were made. An unusually interesting correlation became evident when it was demonstrated that the logarithm of the minimum lethal dose administered showed a nearly linear relationship to the time of survival (Fig. 1). This was used as a standard toxicity curve. Fluorescent measurements were made in the 'Aminco–Bowman' spectrophotofluorometer and calibrated for wave-length and intensity by a standard quinine solution[5]. For this instrument, maxima of activation and fluorescence for the toxin occurred at 287 mμ and 350 mμ, respectively. The fluorescent intensity measured in arbitrary units is linear for toxin concentration below 45 μgm. of protein per ml. ($1{\cdot}4 \times 10^5$ minimum lethal dose). Above this concentration, fluorescent quenching occurs. Except where otherwise indicated, the toxin was dissolved in phosphate buffer (*p*H 6·8, μ 0·15). For this and the other solvents used, correction for blank was negligible. Scattering, which occurs at incident wave-length, is sufficiently separated from the fluorescent maximum to be non-contributing. The fluorescent intensity values are reproducible within 5 per cent even for different preparations of the toxin.

Botulinum toxin retains toxicity at acid or moderately alkaline *p*H values but is rapidly detoxified above *p*H 10. Fluorescent intensity is also retained below *p*H 10, but at higher *p*H-values there is a marked decrease in fluorescence corresponding to the loss in toxicity (Fig. 2). Neither the fluorescence nor

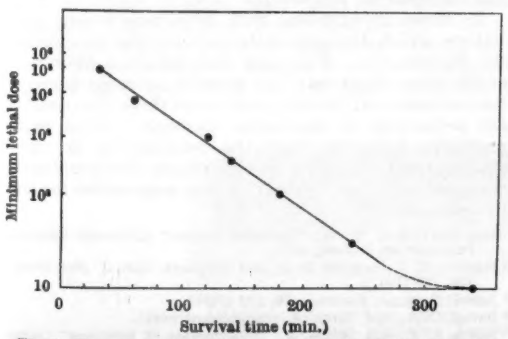

Fig. 1. The survival time of 20-gm. white mice after intravenous injection of dilutions of *Clostridium botulinum* toxin

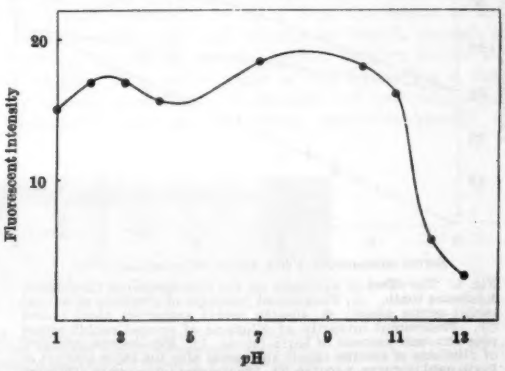

Fig. 2. Effect of *p*H on fluorescent intensity of *Clostridium botulinum* toxin

the toxicity is restored by prolonged dialysis against the original solvent in which the untreated toxin is fully potent. The significance of the smaller decrease in fluorescence near *p*H 5 is not yet clear, and *in vivo* measurements are not sufficiently sensitive to determine that a similar decrease occurs in the toxicity.

Although normal rabbit serum and specific rabbit antiserum (antitoxin) exhibit their own fluorescence, it was shown that the latter decreases the fluorescence of toxin while the former does not. In Fig. 3, the fluorescent intensity of dilutions of normal rabbit serum and specific rabbit antiserum alone are identical (curve *C*); curve *A* shows fluorescent intensity of dilutions of normal rabbit serum plus a constant amount of toxin, while curve *B* shows fluorescent intensity of dilutions of specific rabbit antiserum plus a constant amount of toxin. All samples were incubated at 4° C. for 18 hr. Curve *C* shows a simple increase of fluorescence as the concentration increases (in the non-quenching region). Curve *A* shows a simple additive effect of the fluorescence of the toxin plus the fluorescence of the normal rabbit serum. Curve *B* shows a progressive decrease in the toxin fluorescence as the concentration of specific rabbit serum is increased, suggesting that a combination of toxin and antitoxin has occurred. At the point of fluorescence extinction of the toxin, the toxicity was reduced from the initial value of 100,000 × minimum lethal dose to less than 10 × minimum lethal dose. The slow rate of this reaction is indicated by the fact that an incubation period is required since there is no diminution of toxin fluorescence immediately after the addition of rabbit antiserum.

Since metallic ions interact with active protein groups, a number of metal salts were tested for their effect on fluorescence. The toxin was mixed with dilute solutions (0·01–0·001 *M*) of copper sulphate, cadmium chloride, ferric and ferrous chlorides, chlorides of magnesium and mercury, and zinc sulphate. Of these, only ferric ion showed any effect on fluorescence or toxicity. This ion abolished the fluorescence at 10^{-3} *M* and produced significant depression of fluorescence at 10^{-7} *M*. The effect was immediate and showed no change with time. Ferric ion also depresses toxicity, but at higher concentrations (more than 0·005 *M*) (Fig. 4). The possibility

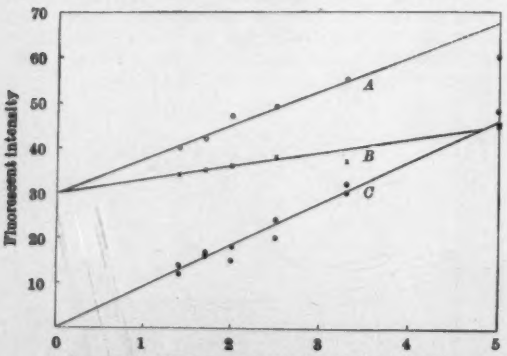

Fig. 3. The effect of antitoxin on the fluorescence of *Clostridium botulinum* toxin. ○, Fluorescent intensity of dilutions of normal rabbit serum alone; ●, specific rabbit antiserum alone (curve *C*). Fluorescent intensity of dilutions of normal rabbit serum plus constant amount of toxin (curve *A*). Fluorescent intensity of dilutions of specific rabbit antiserum plus the same amount of toxin used in curve *A* (curve *B*). Fluorescent intensity in arbitrary units; that of toxin alone = 32

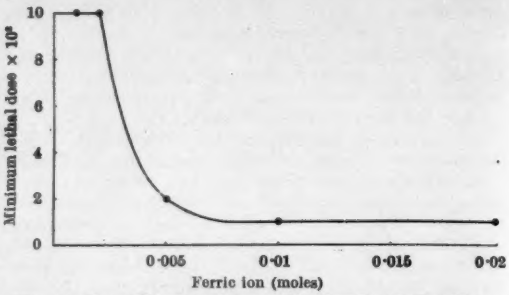

Fig. 4. The effect of ferric ion on the toxicity of *Clostridium botulinum* toxin

that the reaction of the toxin with ferric ion in low concentrations is reversible and occurs *in vivo* has been considered. Preliminary experiments show that 'pre-loading' mice by intravenous injection of 0·3 ml. of 0·01 *M* ferric ion reduces the effectiveness of the toxin by more than 90 per cent.

The dependence of fluorescence on toxicity was also demonstrated by two other means. *Cl. botulinum* when grown under certain conditions of subculture results in a progressive decrease in toxicity of the culture supernates, which is not due to a decrease in bacterial protein. The supernatants of these cultures subjected to our method of toxin purification yield material which appears similar to the substance obtained from fully toxigenic cultures, except that these preparations showed the above-mentioned decrease in toxicity with a corresponding decrease in fluorescence. The fluorescence in these supernatants was shown to decrease corresponding to the decrease in toxicity. Also, toxoid prepared by treatment of the toxin with 0·5 per cent formaldehyde showed no fluorescence.

Since the toxin is a protein and appears to contain no unusual chemical groups[2], the fluorescence is presumably due to the content of amino-acids which fluoresce in the region of the maxima observed, namely, tryptophan, phenylalanine and tyrosine. Purified serum albumin and bovine fibrinogen were also found to fluoresce in this region. The fluorescence intensity of the proteins, however, is much greater than can be accounted for by the sum of the fluorescence of these amino-acids measured alone under the same conditions and in the same concentrations in which they occur in the proteins. Hence, the spatial configuration of these amino-acids in the protein molecule, or of some other otherwise non-fluorescent amino-acids, is probably responsible for the fluorescence produced.

In these experiments with *botulinum* toxin, procedures which diminished the toxicity also diminished the fluorescence. This may indicate that alteration of the gross structure of the protein molecule destroys fluorescence and toxicity, and both these phenomena are properties of the intact molecule. It is more probable, however, that the relationship is more intimate and that some specific region of the molecule responsible for the toxicity is also responsible for the fluorescence.

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THE MESOPAUSE REGION OF THE IONOSPHERE

By Dr. J. B. GREGORY

Department of Physics, University of Canterbury, Christchurch, New Zealand

A PULSE sounding apparatus, specially designed for the study of the lower ionosphere and capable of detecting reflexions the voltage coefficient of which exceeds 5×10^{-6}, has been maintained in operation near Christchurch, New Zealand (43° S.), since early 1955. Transmissions are made at a fixed frequency of 1·75 Mc./s. Initial results previously described[1] have now been largely confirmed. Extended observations suggest that there are some features of the ionosphere below 100 km. that deserve closer study in different latitudes. The most important of these features is the continuous existence of ionization throughout a range of heights commencing at a little above 80 km. and extending to about 100 km. Fig. 1 shows a plot of the lower boundary heights of reflexions from this region for four undisturbed days in the various seasons. The strength of the reflexions from this region varies through a range of about 70 db. Between 85 and 90 km., reflexions with a coefficient greater than 10^{-3} have been noted during day and night on many occasions. I have shown[2] that these partial reflexions detected at vertical incidence, together with those from lower heights, are the medium-frequency counterpart of the oblique scattering of very-high-frequency waves now utilized for communication purposes.

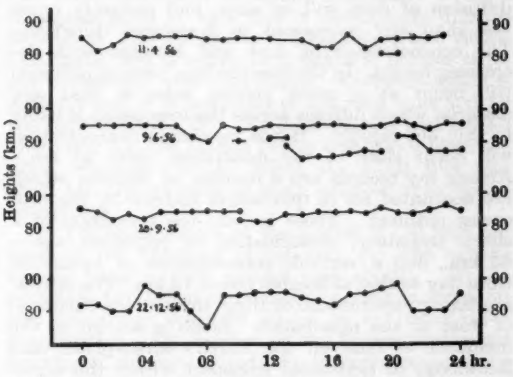

Fig. 1. Lower boundary heights of the mesopause layer at all seasons

A characteristic of the reflexions near 85 km. is the formation of a sharp lower boundary, which may persist for several hours with little change in height. This discontinuity in ionization density usually continues during daylight hours despite the presence of reflexions immediately below it. The 1·75 Mc./s. observations indicate that the major change in ionization density below the *E*-region is more often near 85 km. than elsewhere. At night, the lowest height at which reflexions are detected is often close to 85 km. Initial observations suggested that the night boundary did not descend below 80 km., but later work has shown that ionization at night does remain to a much greater extent and at lower heights than has previously been reported. Fig. 2 shows a record taken at 0145 N.Z.S.T. on May 22, 1956, in which a distinct region at 73 km. is visible in addition to rapidly fading reflexions at 85 km. and sporadic-*E* at 105 km. The lower reflexions were present at heights between 73 km. and 75 km. at hourly intervals of observation throughout the night of May 21–22, with a reflexion coefficient which varied between 5×10^{-5} and 5×10^{-4}. Numerous examples, mostly in winter, are available of reflexions from as low as 75 km. The lowest recorded height at night occurred on May 27, 1957, at 0530 N.Z.S.T., that is to say, about eleven hours after sunset and two hours before sunrise, when weak reflexions from a height of 67 km. were noted during the 8 min. required for a routine observation of heights and strengths of reflexions. This particular event occurred during a 24-hr. period which was part of a group of winter days of high absorption, and during this period the lower boundary of the main reflecting region below the *E*-region did not rise above 78 km.

Fig. 1 shows that the reflexion heights between 80 and 90 km. are largely independent of solar control. It is thus necessary to show how ionization of low recombination-rate may always be found, though in varying quantities, within limited heights below the *E*-region. A possible origin of this ionization is dust or debris, composed of elements of low ionization potentials such as are found spectroscopically in

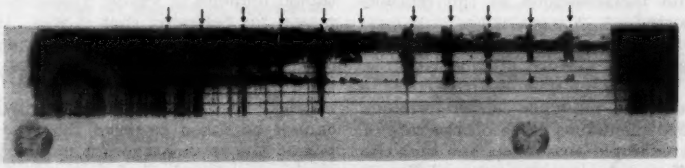

Fig. 2. *h't* Record: 1·75 Mc./s., May 22, 1956, at 0145 N.Z.S.T. Reflexions are visible with lower boundaries at 73 km., 85 km. and 105 km. (Height markers commence at 45 km., and follow at 10 km. intervals. Receiver gain is reduced in a series of 6 db. steps, the start of each reduction being marked by an arrow above. A short interval of increased gain precedes each reduction)

meteors. When photo-ionized, this material would recombine only by radiative processes. Observed electron densities appear to require concentrations of dust that are unlikely to be produced by ablation of meteors detected visually or by means of radar; and hence an extra-terrestrial origin is supported. The existence of meteor atoms as a constituent of the *E*-region has been suggested by Nicolet[3].

The increase in concentration of this dust near 85 km., and the formation of a sharp lower boundary at this height, may be explained as follows. In the temperature inversion above the mesopause, vertical diffusion of dust will be slow, and certainly much less than any movement in horizontal directions. The concentration of dust will increase with decreasing height. In the mesodecline, vertical diffusion will occur at a much greater rate, so that any material which diffuses across the mesopause is likely to thin out rapidly. Hence maximum concentration will occur close to the mesopause (near 85 km.). Among my records are a number of features which are accounted for in qualitative fashion by the processes outlined. These include the formation of a sharp boundary, stratification of reflexions above 85 km., and a variable concentration of ionization from day to day at heights below 70 km. The optical scattering experiments of Bigg[4] support the existence of dust at the mesopause. Little is known of the incidence of dust on the Earth's atmosphere, and knowledge of horizontal transport within the atmosphere will be required before the radio method can give information as to its rate of arrival. Sufficient evidence is available to confirm its existence, and to show that physical rather than photo-chemical factors are responsible for the formation of a mesopause region of the ionosphere.

The enhancement of ionization at heights above 67 km. during winter days of high absorption has been demonstrated by me[1]. The low recombination-rate at night of this ionization, revealed by later work, raises the possibility that the extra constituent present during these periods may also be meteoric dust. If this proves to be the case, then the seasonal and latitude aspects of the high-absorption effect will require an explanation in terms of the upper-atmosphere circulation pattern. I believe that my records show some evidence that horizontal transport of the extra constituent may occur above the mesopause, but more work is required to confirm this view. At present, available information relating to atmospheric sodium[5], which shows a peak of radiation intensity near the mesopause, suggests that transport from the pole towards the equator is likely.

The suggestions advanced in this communication are being pursued, and results of a detailed analysis of a year's observations of the lower ionosphere will be presented at a later date.

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USE OF 'BROOD PATTERNS' IN RESEARCH ON CHEMICAL MUTAGENS

IN a recent article in *Nature*[1], Drs. O. G. and M. J. Fahmy have used a few brood patterns of mutation frequencies after treatment with certain sulphonates for building up far-reaching speculations on the action of these compounds. Since I have had many years of experience with this kind of approach to the study of chemical mutagenesis[2], may I be permitted to pronounce a warning against its incautious use. My points of criticism are too numerous and too technical to be discussed fully here; they will be published *in extenso* elsewhere[3]. Here I only want to enumerate briefly the most important ones.

(*a*) There has been no proof that the methods used by Drs. Fahmy result in repeatable brood patterns in replicate experiments. On the contrary, the reference to these 'standardized' methods is to a paper[4] which illustrates strikingly the lack of uniformity in replicate experiments, and no modifications of the method have ever been reported.

(*b*) The claim that with the methods used "spermatogonia differentiate into mature sperm within a period of 15 days" is wholly unsubstantiated. It leaves out of account the influence which different kinds of chemical treatment may have on the rate of sperm release. An example that even one and the same chemical in different doses may produce different brood patterns is shown in Fig. 1 of Drs. Fahmy's article[1]: after treatment with the lower dose of methyl methanesulphonate, mutation-frequency dropped from 5·2 per cent in the third brood to 3·9 per cent in the fourth; after treatment with the higher dose these two broods had the same frequency of lethals. Drs. Fahmy base their interpretation of brood patterns on an investigation[5] in which the brood pattern for triethylene melamine was interpreted by reference to the histological picture of the treated testis, a method which—unsupported by genetical tests[6]—leaves a wide margin of error. In any event, its results are applicable to triethylene melamine, and to that substance only; they have no validity for other substances.

(*c*) There is no proof for the claim that after treatment with chloroethyl methane sulphonate (*CB* 1506) the fifth brood is drawn from the latest spermatogonia, "just before they started metamorphosing into spermatocytes". It is true that this brood had been drawn from treated spermatogonia, because it contained bunches of visible mutations. But there is no reason for believing that it was "the first brood" to do so; for since the previous brood did not contain any visible mutations at all[7], it is hard to see how they could have formed bunches. In addition, the absence of bunches from limited sperm samples cannot be taken as proof that the treated cells had passed the spermatogonial stage; for late spermatogonia give bunches of two, which can be detected only in very large-scale tests.

(*d*) The application of statistical methods to brood patterns has to be carried out with great care;

differences between two points may appear to be significant in one experiment and insignificant in a replication. Much of the hypothesis concerning the action of *CB* 1506 is based on a difference between eight lethals in the third brood and two in the fourth[7], a difference which by chance would occur once in about twenty experiments, and which on application of Yates's correction for small numbers becomes insignificant. The same paper[7] presents data from a second experiment with *CB* 1506, carried out on twice the scale with two-thirds the dose. Here the difference between mutation-rates in the third and fourth broods is wholly negligible (χ^2 less than 1). It seems risky indeed to erect a speculative building on such a shaky foundation. It is true that meanwhile Purdom[8] has published two or more brood pattern curves for *CB* 1506 which resemble the one presented by Drs. Fahmy[1] in their main features, although not in detail. In particular, both these curves show a slight and statistically insignificant drop ($\chi^2 = 1{\cdot}4$ and $0{\cdot}5$) from the third to the fourth brood. It is thus possible that such a drop, which rarely seems to reach the level of statistical significance, is indeed a feature of the brood pattern produced by *CB* 1506.

Since Purdom's data are not used by Drs. Fahmy[1], they are, however, not relevant to my criticism, which is directed against the *methods* of Drs. Fahmy, not against the possibility that some of their very insecurely based conclusions may, on further experimentation, turn out to have been inspired guesses. While, in my opinion, the interpretation of the brood pattern for *CB* 1506 gives too much weight to a scarcely significant difference, the opposite error may have been committed in regard to ethyl methane sulphonate. Here the drop in mutation frequency from the first to the second brood (ref. 1, curve *A*, Fig. 1) is disregarded as statistically not significant; but it might well be significant in repeated experiments. This would bring ethyl methane sulphonate into line with diepoxybutane for which, on the basis of one experiment, such a drop has been claimed as a distinguishing feature, and with triethylene melamine, for which a similar drop seems highly characteristic[5].

(*e*) The application of statistical methods to frequencies of visible mutations is even more misleading, because of the large personal factor involved in the scoring of these mutations. That even Drs. Fahmy are open to this criticism is illustrated strikingly by the fact that no visible mutations were reported among more than a hundred mutations in the first experiments with phenyl alanine mustard[10], a substance which afterwards has been stated to have "an extraordinary efficiency in the induction of visible point mutations", yielding regularly a ratio of three visible to ten lethal sex-linked mutations[11,12].

If one nevertheless insists on the use of statistical methods for experiments on visible mutations, account will have to be taken of heterogeneities within the samples to be compared. This has not been done for the noticeable—and statistically significant—drop in the ratio of visible to lethal mutations from the first to the fourth brood after the treatments listed in Table 1 (ref. 1). Moreover, the vast majority of mutations which have been produced by *CB* 1506 occur in germ cells which do not respond to the action of the other sulphonates; comparisons involving *CB* 1506 and one of these other substances are therefore comparisons not only of different mutagens, but also of different cell types. The importance of this distinction has recently been emphasized by Purdom[8], whose results show the important part played by germinal selection in influencing the relative frequencies of sex-linked visible and lethal mutations, when these are recovered from different stages of spermatogenesis.

(*f*) Drs. Fahmy[13] attribute the alleged differences in the visible/lethal ratios after different chemical treatments to the fact that certain 'morphogenesis loci' react specifically to certain chemicals. From a biological point of view this is exceedingly difficult to believe. The classification of mutations into visible and lethal ones is convenient, but it is neither strict nor biologically very meaningful. Every mutation is a visible one, if it is studied at the right time and by the right method. The only distinction is that lethals affect and kill the animal before emergence from the pupa, whereas 'visibles' affect the adult flies and often kill a proportion of them after or even before emergence.

(*g*) The speculations on the action of *CB* 1506 are open to the following objections: (1) The experimental basis is very slender (see above). (2) To postulate two different mutagens acting in series on two selectively sensitive stages is an uncalled-for complication. (3) In view of the known mutagenic activity of chloroethyl radicals, it seems unnecessary to postulate the formation of a chloroethyl amino-acid compound. In any event, the outcome of the proposed experiment with chloroethyl cysteine would be decisive only with very special assumptions which will be more fully discussed in *Z.i.A.V.*[3]. (4) Biological factors, such as differential penetration, selection, differences in rate and quality of metabolism, are wholly neglected. Experiments by Miss E. M. Sonbati and myself indicate that some of them influence the mutagenic action of *CB* 1506. (5) For reasons of scientific economy, the chosen interpretation of the brood pattern of *CB* 1506 should be adaptable also to an unrelated substance, 2-3-*bis*-ethylene amino-benzoquinone-1.4, which gives a similar brood pattern[13].

C. Auerbach

Institute of Animal Genetics,
Edinburgh.

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In the study of chemical mutagenesis on *Drosophila*, quantitative consistency of genetic response largely depends on the method of administration of the compound under test. The indirect methods of

administration, especially that of mixing the compound with the food of the larvæ, result in complete lack of mutagenic consistency both in relation to the dose effect and the brood-mutation pattern[1]. This is perhaps what led Auerbach[2] to contest the possible achievement of reasonable consistency of brood-mutation patterns with the direct method of administration of the mutagens as developed in our laboratory.

(1) *The injection technique and mutagenic consistency.* With our method, accurately measured volumes of a solution of the compound are injected (by a micrometer-syringe) directly around the testes of males of the same age and average weight. In these circumstances, it has been shown[3–5] that for some compounds there is a fairly accurate and consistent relationship between the physical dose injected and the mutation-rate recovered. When the fractionation of the progeny of the treated males is undertaken at the same set periods, reasonable consistency of the brood-mutation pattern does occur, particularly within narrow dose-ranges. This has now been repeatedly ascertained for several alkylating compounds (unpublished) and is quite obvious from the published data, especially with the alkyl-methanesulphonates. The two experiments with 2-chloroethyl methanesulphonate[6], as well as a third undertaken by the same method and in our laboratory by Purdom[7], are clearly very similar; also those for methyl methanesulphonate[8] are almost diagrammatically identical. More extensive and comparable data with the above and related compounds are available, but obviously could not be included in the brief notes so far published.

The conclusion that with our standard brood technique spermatogonia differentiate into mature sperm within *roughly* 15 days is based on more than one line of evidence. We have already referred to the histo-genetic results with 2 : 4 : 6-tri(ethyleneimino)-1 : 3 : 5-triazine[4], which showed that pre-meiotic germ cells (spermatocytes and spermatogonia) give sperm which is utilized starting from the fifth brood, 13–15 days after treatment. That this timing applies equally well to 2-chloroethyl methanesulphonate is indicated by the appearance of 'visible' clusters in the fifth brood. Furthermore, the 'N-mustard' derivatives of amino-acids induce mutations at fairly high rates in all stages of spermatogenesis. In several of our recent experiments with these compounds, 'visible' clusters first appeared in the fifth brood. We feel justified in concluding, therefore, that under our experimental conditions, sperm *mainly* derived from spermatogonia is utilized in the fifth brood (within 15 days), irrespective of the treatment. This possibly means that under mild doses of the alkylating agents, the speed of germ-line differentiation is not drastically disturbed.

(2) *The brood-mutation curve and chemical reactivity.* Auerbach[2] emphasizes the lack of statistical significance for the drop in mutation-rate from the third to the fourth brood under the effect of the lower dose of 2-chloroethyl methanesulphonate[6]. This, however, is not essential to the hypothesis[6] we were expounding, namely, whether the rise in mutation-rate as a function of time after treatment (due to the possible retention of a slow-reacting compound) does continue after the third brood. The regression coefficients of mutations on broods (over the first three broods) for the two experiments (Table 1, ref. 6) did not differ significantly from each other. A conjoint coefficient was, therefore, calculated which indicated an increase in lethal percentage of 1·68 each brood. On this basis, the expected mutation-rate at the fourth brood for the lower dose would be 5·1 per cent, as compared to the observed 2·3 per cent (for the sample of chromosomes tested, $\chi^2 = 8·3$, deg. freedom = 1, $P = 0·006$). This clearly indicates that the mutation-rate observed in the sperm of the fourth brood is *very significantly* lower than expected on the hypothesis that the cells from which it is recovered have received a longer time of treatment than those utilized in the third brood. As postulated[6], this is probably due to the destruction of the 'residual' chloroethyl ester by hydrolysis (and other physiological factors) within less than the period of four broods (less than 12 days). It follows, therefore, that the much higher mutation-rate in spermatogonia which are utilized later than the fourth brood cannot be a function of time. Supporting evidence comes from the results with the fluoroethyl ester[8], which also possesses a slow-reacting methanesulphonoxy group and yet it does *not* induce a high mutation-rate in spermatogonia.

(3) *'Visible' mutations.* Auerbach[2] interpreted the lack of reference to 'visibles' in our preliminary reports on the 'N-mustard' derivatives of phenylalanine as evidence that none of these mutations was observed. Actually, the ratio of visibles to lethals in *all* our experiments with this mustard was of the order of 3 : 10. In the interim reports she referred to, only the lethal rates were given, and nothing whatever was said about the 'visibles'.

The statement[2] as to the heterogeneity of the ratio of visibles to lethals in the separate broods with the treatments listed in Table 1 of ref. 8 is rather ambiguous, since these data belong to two different compounds. A contingency table test for the relative frequency of these mutations in broods 1–4 gave for the ethyl ester $\chi^2 = 1·8$, deg. freedom = 3, $P = 0·6$, and for the methyl ester $\chi^2 = 7·05$, deg. freedom = 3, $P = 0·07$, thus revealing no pronounced heterogeneity.

Auerbach[2] raises the question of the possible role of cell-stage and germinal selection on the ratio of visibles to lethals recovered from various germ cells. This point will be dealt with in detail in a future publication. Suffice to say, however, that for all the alkylating mutagens tested in our laboratory, the ratio of sex-linked visibles to lethals for the same compound does not differ significantly for the separate broods up to and including the sixth. This ratio, however, was sometimes disturbed in favour of the visibles (presumably by differential germinal selection against the lethals) for mutations induced in the *very early* spermatogonia, which are recovered in the seventh brood (19–21 days after treatment). These mutations, however, did not contribute sufficiently to the total mutation pool in any of our experiments to alter significantly the overall ratio characteristic of the various compounds.

The exact biological mechanisms responsible for the variation in the ratio of visibles to lethals under the effect of different mutagens is at present entirely unknown and is one of the problems receiving attention in our laboratory. It may be a manifestation of various degrees of damage to the same loci; but might well be due to selective action on different loci. The merits of each of these views will be dealt with elsewhere, but whichever view is pre-

ferred can scarcely affect our conclusion: that if mutagens induce different ratios of visibles to lethals in the same sample of treated chromosomes, their mode of mutagenic action is somehow different.

(4) *Mode of mutagenic action of 2-chloroethyl methanesulphonate.* Our interpretation[8] of the mode of mutagenic action of 2-chloroethyl methanesulphonate is based on the comparative study of the chemical reactivity and mutagenicity of the above compound and some closely related alkyl-methanesulphonates. The mutagenic criteria considered were gross trends and points of detail were only mentioned as complementary evidence. Our argument rests on the complete reversal of the mutagenic cell-stage response under the effect of 2-chloroethyl methanesulphonate as compared with that of other alkyl methanesulphonates including the ethyl ester (see Fig. 2, ref. 8). As clearly stated in our contribution[8], and has been shown experimentally[6], changes in the brood-mutation pattern do occur with some compounds, due to cells being killed by the treatment, variation in the speed of differentiation of the germline, or on altering the experimental procedure, particularly the brood period. These changes, however, are of a much lower order than the gross difference that differentiates the mutation pattern of the chloroethyl ester from that of other alkyl-methanesulphonates.

Auerbach[2] suggests that the differential mutagenicity of the chloroethyl ester may be a function of the chloroethyl group which, she maintains, is known to be mutagenic. However, the fact that the chloroethyl group in 'mustards' (S- and N-mustards) is mutagenic does not mean that it is always so, irrespective of the configuration of the rest of the molecule. The biological activity of the chloroethyl group in 'N-mustards' has been shown by Ross[10] to be due to the tendency of these compounds to produce 'electrophilic' carbonium ions which would be expected to react with the 'nucleophilic' centres in the cell—particularly those of nucleic acids. Ross also demonstrated that the above tendency could be measured *in vitro* by the rate of hydrolysis of the chlorine atom under mild conditions. Since with 2-chloroethyl methanesulphonate, the chlorine atom does not hydrolyse in water at 37° C., whereas the methanesulphonoxy group does, there can scarcely be any doubt that the potential alkylating ability of the chloroethyl ester initially starts at the methanesulphonoxy end, as is the case with the other alkyl-methanesulphonates. If, however, the product of the initial reaction could be such as to 'activate' the chlorine atom of the chloroethyl group, then another alkylating centre would have been secondarily produced. Hence the search for the secondary agent that could account for the atypical mutagenic properties of the chloroethyl ester.

As clearly admitted in our article[8], the suggested formation of a secondary mutagen under the effect of 2-chloroethyl methanesulphonate was only inferential, and our idea about its chemical nature was purely speculative, but experiments were designed for testing our hypotheses. The first series of experiments using S-chloroethyl cysteine (one of the possible metabolites) has now been undertaken. The brood-mutation pattern for this compound was found to be of essentially the same type as that for 2-chloroethyl methanesulphonate, though indicating far greater selectivity for the early germ cells (details to be published elsewhere). An injected concentration of S-chloroethyl cysteine as low as $0{\cdot}4 \times 10^{-3}$ molar induces a sex-linked recessive lethal-rate of 30 per cent in the most sensitive spermatogonia as compared to a maximum of only 1·6 per cent among the sperm and spermatid stages. Other amino-acid mustards that are likely to be produced *in vivo* through the effect of the chloroethyl ester (particularly in conjunction with cysteine metabolism) will be tested for mutagenicity. However, the results with S-chloroethyl cysteine suggest that our reasoning as to the mode of mutagenic action of 2-chloroethyl methanesulphonate was on the correct lines: that the high response of spermatogonia under its effect is probably due to the production *in vivo* of a secondary mutagen other than the sulphonate itself.

O. G. Fahmy
Myrtle J. Fahmy
Chester Beatty Research Institute,
Institute of Cancer Research,
Royal Cancer Hospital,
London, S.W.3.

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The editors of *Nature* have kindly given me leave to wind up this discussion with a few lines; they do not wish a continuation of technicalities, and I refer, therefore, for details of my criticism to my paper in *Z.i.A.V.* Here I only want to say this: although the reply by Drs. Fahmy seems to meet all my objections, it does in fact, on closer analysis, confirm that their methods and reasoning were, point for point, exactly as stated and criticized by me. Their reply contains no new references to published data; their insistence on the repeatability, in their experiments, of the relation between dose and effect is wholly irrelevant to the argument; the calculation in section 2 is based on too specious an argument to be taken seriously; finally, it is very difficult to understand why "an extraordinary efficiency in the production of visible mutations" by certain compounds should have been noted but not mentioned for a full year during which two lengthy interim reports came out, especially as this result was first made public in exactly the same kind of interim report. If the speculations on the action of *CB* 1506 have led to the discovery of a further interesting mutagen, they certainly have had heuristic value. It does not follow, however, that they were correct or even well founded. Two substances may well produce similar brood patterns without one being a metabolic descendant of the other (see the last section of my communication above). Moreover, it would not be the first time that an effective mutagen has been detected on the basis of a wrong or doubtful hypothesis.

C. Auerbach
Institute of Animal Genetics,
Edinburgh.

LETTERS TO THE EDITORS

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X-Ray Study of Laboratory-made Diamonds

Last summer one of us was able, through the courtesy of the General Electric Co., of Schenectady, New York, to select a few of the diamonds made in the Company's Research Laboratories and to bring them to University College, London, for detailed X-ray examinations. These diamonds are mostly very small (less than $\frac{1}{8}$ mm. linear) and are coloured (yellow, green, black) and good shapes are rare. Although some colourless diamonds have been made, there were none among our collection, nor did we have any of those of pure cubic form. The habits, which are exceedingly interesting, will be discussed in the more extended account of this work to be published later.

Fig. 1. (a) Twinned natural diamond. Rotation slightly mis-set from [011] for one individual: showing 111, 022, 311, 222 (very weak) 400, 133 reflexions. Copper K radiation, filtered. (b) Twinned laboratory-made diamond: same setting and radiation; showing, in addition to the above, the 'forbidden' 200 (medium) and 420 (very weak) reflexions, with very weak satellites to all others. Only the 200 spots are clearly visible on the reproduction

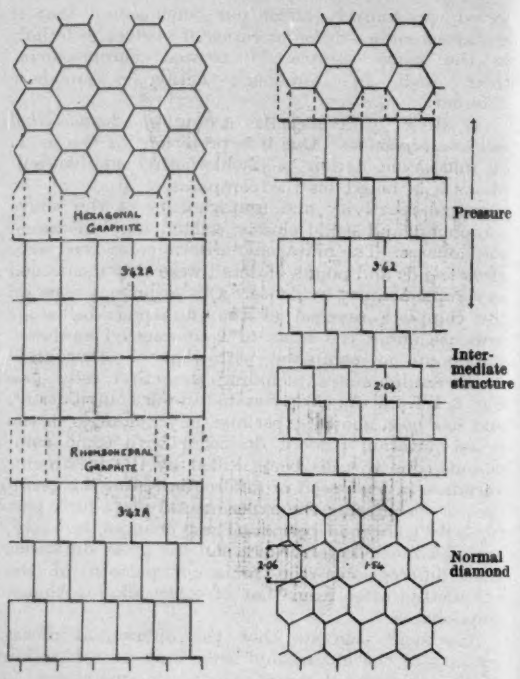


Fig. 2

Ten representative specimens have been studied so far. Laue photographs show that only two crystals are comparatively single and free from distortion; but five have given, using chromium, nickel, copper and molybdenum radiations, good rotation and/or Weissenberg photographs (about [001] and [01$\bar{1}$]) on which it is easy to distinguish spots due to the main specimen from those of its associated twin. In every case these laboratory-made diamonds show one outstanding diffraction feature, namely, the presence of a comparatively strong 200 reflexion, which is never shown by any natural diamond, whether of terrestrial or meteoritic origin, that we have studied. There are other 'forbidden' reflexions (h, k, l even and $h + k + l = 4n + 2$) present also, and nearly all the normal diamond reflexions show a faint satellite on the short-spacing side (Fig. 1).

All the low-order reflexions are sharp, but the 'forbidden' and 'satellite' spots are sometimes a little extended along arcs with θ constant, showing that they are given by a mosaic or conglomerate of slightly disorientated crystallites.

The explanation of the diffraction phenomena appears to be as follows. Each diamond consists of a matrix of normal diamond, of lattice constant 3·567 A., with carbon atoms at the usual positions:

$$000,\ 0\tfrac{1}{2}\tfrac{1}{2},\ \tfrac{1}{2}0\tfrac{1}{2},\ \tfrac{1}{2}\tfrac{1}{2}0\ +\ |000,\ \tfrac{1}{4}\tfrac{1}{4}\tfrac{1}{4}|$$

in each unit cell. Within this matrix there are islands of a different structure which is face-centred cubic with lattice constant 3·54 A. These islands lie closely parallel with the diamond matrix and must be at least 10,000 A. across to account for the sharpness of the reflexions, although some broadening of the 331 and 420 indicates possible distortion or strain.

A spectroscopic analysis of the diamonds, carried out in Messrs. Johnson Matthey's Research Labora-

tories, demonstrates the presence of some 0·2 per cent of nickel, with smaller quantities of other elements (Si, Al, Fe, Mn, Mg, Na, K, Ti, Ca, Cr, Cu, B). This points to a probable explanation of the subsidiary structure. β-Nickel has a face-centred cubic structure of lattice constant 3·52 A.; nickel carbide, a solid solution Ni_xC where $x \geqslant 4$, is face-centred cubic above 210° C. and has[1] the slightly higher parameter 3·54 A. A simple face-centred cubic structure would not account for the high intensity of 200 relative to other lines in the satellite structure. The addition of some impurity or solvent atoms could do so. A calculation shows that for incident nickel, copper $K\alpha$ or molybdenum radiation, even so small an amount of nickel as 0·2 per cent, concentrated in a few well-crystallized and parallel islands, would give reflexions of appreciable intensity, but that for chromium or copper $K\beta$ radiation they would be much reduced in intensity if the extent of each island is more than some 4×10^{-4} cm. linear. This reduction in intensity is found to occur.

Nickel does not normally appear as an impurity in natural diamonds. The closeness of its lattice constant to that of diamond would point to it, however, as a possible inducer of crystallization of carbon in the diamond form (much as β silver iodide can induce the precipitation of ice in clouds). The process of cooling from high temperatures and simultaneously expanding from high pressures could well leave islands of face-centred cubic nickel or Ni_xC or some other nickel compound in a state of strain; and the existence of orientation relationships (not necessarily complete parallelism) in a precipitated phase is typical, for example, of Widmanstätten patterns in iron-rich nickel–iron alloys in diamond-bearing meteorites. The presence of nickel in these laboratory-made diamonds recalls the Press release (February 15, 1955) by the Research Laboratory of the General Electric Co., in which it was stated that its scientists had "gained valuable help from nature, particularly from studies of diamonds found in Arizona meteorites". This will be discussed in our later paper.

The question still remains as to the actual mechanism of transformation from graphitic carbon (assuming this to be the initial substance) to diamond. This could in fact occur via an intermediate carbon structure, as shown in Fig. 2. This structure, if it has carbon atoms in the positions ($x \sim \frac{1}{24}$)

$$000,\ 0\tfrac{1}{2}\tfrac{1}{2},\ \tfrac{1}{2}0\tfrac{1}{2},\ \tfrac{1}{2}\tfrac{1}{2}0 + |\ \bar{x}\bar{x}\bar{x};\ \tfrac{1}{4}+x,\ \tfrac{1}{4}+x,\ \tfrac{1}{4}+x\ |$$

in a unit cell which is geometrically cubic, of side 3·54 A., but of rhombohedral symmetry only, would give reflexions in precisely the positions of the satellite spots. Apart from the variation of absorption factor with incident radiation, the occurrence of such an intermediate structure, in islands, each with its trigonal axis orientated parallel to one of the four diamond octahedral directions, could scarcely be distinguished from that of the nickel-rich islands we have postulated as the main cause of the satellite reflexions.

Nath[2] suggested in 1935 that the reverse transformation, diamond → graphite, might take place via rhombohedral graphite, but no experimental evidence of this has yet been found, even in heavily irradiated or heat-treated diamonds[3]. We should also emphasize that even the blackest of the laboratory-made diamonds examined showed no trace whatever of the strong 0002 reflexion typical of both hexagonal and rhombohedral graphites, or any other purely graphitic reflexion.

We would like to express our thanks to members of the research staff of the General Electric Company, Schenectady, who, within the limitations of United States security regulations, have given us every assistance in this investigation.

H. Judith Grenville-Wells
Kathleen Lonsdale

University College,
London, W.C.1.

[1] Bernier, R., *Ann. Chim.*, 6, 104 (1951); distances given here as in A. are really in kX., and must be multiplied by 1·00202.
[2] Nath, N. S. N., *Proc. Ind. Acad. Sci.*, A, 1, 841 (1935).
[3] Grenville-Wells, H. J., Thesis, London (1951).

Nuclear Quadrupole Resonance of Neutron-irradiated Sodium Chlorate

Recently a method based on intensity measurements in pure quadrupole resonance has been developed and has proved itself useful for the study of solid solutions[1] and for the investigation of the damage induced in pure solid compounds by high-energy radiations such as gamma-rays[2].

The present work was undertaken in order to try to extend this method to the case of neutrons. With this in view, fused samples of sodium chlorate, which presents a favourable signal-to-noise ratio, were irradiated at 95° C. in the Belgian *BR*–1 reactor in which a high ratio of neutron to gamma energy is provided. A frequency-modulated super-regenerative detector was used and the spectra were automatically recorded after phase-sensitive detection of the signals.

The observations performed at 23° C. showed that the height of the line (located at 29·932 Mc./sec.) corresponding to chlorine-35 was decreased by about 25, 36 and 52 per cent for irradiations with doses of 2×10^{14}, 10^{15} and 2×10^{15} fast neutrons cm.$^{-2}$, respectively. We were unable to detect any significant shift in the line frequency and, as was found to occur with the gamma-rays[2], a plot of $\log I$ (irradiated sample) $-\log I_0$ (unirradiated sample) versus the dose gave a straight line. This shows that, despite a different type of effect, an exponential law still describes the intensity behaviour. It should be noticed that, within the range of doses used, no significant broadening of the line (measured by the separation between the peaks of the first derivative curve) was observed. For this reason, the intensity of the line was regarded as being satisfactorily represented by its height.

It may now be stated that the method here reported is also valuable for the study of damage induced by neutrons. Further research, including radio-resistance in terms of structure and recovery effects, is now in progress.

We are indebted to the Centre d'Etudes pour les applications de l'Energie Nucléaire for irradiation facilities.

Joseph Depireux
Jules Duchesne

Institut d'Astrophysique,
University of Liège. Jan. 10.

[1] Duchesne, J., and Monfils, A., *C.R. Acad. Sci., Paris*, **238**, 1801 (1954). Dean, C., *J. Chem. Phys.*, **23**, 1734 (1955). Segel, S. L., and Lutz, B. C., *Phys. Rev.*, **98**, 1183 (1955). Monfils, A., and Grosjean, D., *Physica*, **22**, 541 (1956). Michel, R. E., and Spence, R. D., *J. Chem. Phys.*, **26**, 954 (1956). Dreyfus, B., and Dautreppe, D., *C.R. Acad. Sci., Paris*, **243**, 1517 (1956). Woessner, D. E., and Gutowsky, H. S., *J. Chem. Phys.*, **27**, 1072 (1957).
[2] Duchesne, J., Monfils, A., and Garsou, J., *J. Chem. Phys.*, **23**, 1969 (1955). Monfils, A., and Duchesne, J., *Physica*, **22**, 818 (1956). Duchesne, J., Monfils, A., and Depireux, J., *C.R. Acad. Sci., Paris*, **243**, 250 (1956). Duchesne, J., *Arch. Sci. Genève*, **10**, 257 (1957).

Flame Ionization Detector for Gas Chromatography

It has been found that the electrical conductivity of a flame burning a mixture of hydrogen and nitrogen (in air) is very sensitively affected by the vapours of organic substances, and this effect can be used for detection purposes in gas chromatography.

In a simple form of the detector the carrier gas used was a mixture of approximately equal parts by volume of hydrogen and nitrogen and the issuing gas was burnt at a jet made from a 23-gauge hypodermic needle (cut square) which itself served as the positive pole for the conductance measurement. The negative pole consisted of a piece of 30-mesh brass gauze, about 1 cm. above the needle, and the current, driven by a battery of about 300 volts, passed through a 100,000-ohm resistor, across which a Leeds and Northrup 10-mV. potentiometric recorder was connected. The sensitivity of this arrangement to organic vapours was at least as good as reported for the best katharometers.

For the highest sensitivity yet obtained, a double triode 'long-tailed pair' impedance conversion circuit was used (voltage gain about × 2), with a reference jet (burning the same gas mixture) feeding one grid and the detection jet feeding the other. Circuit details are shown in Fig. 1.

The valve is an *E80CC* (Philips), heaters in series with a 12-volt accumulator. The output is filtered with an *RC* circuit with a time constant of about 5 sec. The combustion chamber and collector leads are completely shielded. The combustion chamber is supplied with filtered air since dust particles cause large disturbances.

With the jets connected to short partition columns, injection of 0·01 ml. of a solution of one part of diethyl ether in 10,000,000 of ethyl acetate (by liquid volume) gave an output of about 1 mV. for the ether peak, which was eluted during the passage of 100 ml. of carrier gas. This deflexion was about five times the background fluctuations, and the sensitivity (for twice background) was estimated at not less than 5×10^{-12} mole of diethyl ether, or 4×10^{-10} gm. The sensitivity at the point of detection was about one part in 400 million (by gas volume). From the daily variations in background, it is thought probable that the sensitivity is at present limited by the quality of the insulation and the stability of the grid resistors rather than by the stability of the flame outputs. (Much higher output could be obtained with higher grid resistances, provided background was not proportional.)

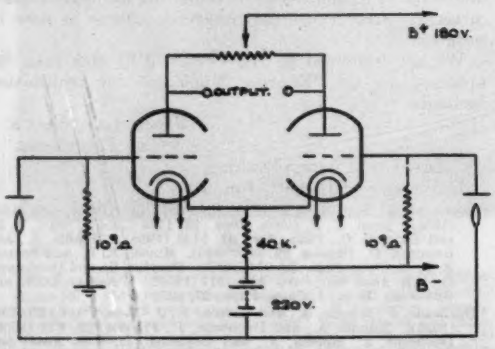


Fig. 1. Circuit of dual-jet detector

With the double-jet system fed with the same gas mixture to both columns, the base line is remarkably insensitive to nitrogen–hydrogen ratio, total flow-rate, vibration, ambient temperature or minor variations in the supply of filtered air. The air supply is passed straight into the bottom of the jet chamber without any device to suppress turbulence.

Other organic vapours so far tried give sensitive responses, including benzene, toluene, xylene, carbon tetrachloride and methylene chloride. Very little if any response is obtained with carbon dioxide.

Preliminary measurements and calculations based on Faraday's law, appear to indicate an ion yield of between one and ten ions per 10,000 molecules of ether, but further investigations, using electrometer valves with very low grid currents, are planned. It is hoped to publish the results at a later date.

A remarkable demonstration of the sensitivity of the apparatus (and of the difficulty of producing known concentrations of vapour by serial dilution) is given by charging an ordinary 2 ml. glass hypodermic syringe with ether vapour, pumping out completely about 100 times, and then injecting a syringeful of air. A peak of several millivolts is obtained, from ether desorbed from the glass.

The above detector was described at a discussion on gas chromatography held at Cambridge on October 4, 1957.

We thank Imperial Chemical Industries of Australia and New Zealand for permission to publish this communication, L. E. Polak, S. Lattimore and F. A. Walter for invaluable advice on the electronics, and V. E. Maier and W. J. Bryant for able assistance.

I. G. McWilliam
R. A. Dewar
Imperial Chemical Industries of Australia and New Zealand, Ltd.,
Central Research Laboratory,
Ascot Vale, Victoria, Australia.

Polarization of the Integrated Light of Comet Arend-Roland, 1956*h*

From a pair of photographs of the comet taken on the night of April 29–30, 1957, through a 'Polaroid' filter with the 50-cm. Zeiss triplet of the Mond Astrograph, percentage polarization in integrated light (spectral range, 4000–5900 A.) has been measured in the brightest part of the coma, and also at two locations in the tail 4 and 5 min. of arc respectively from the former position. The small scale of the photographs (6·85 min. of arc/mm.) prevented any attempt at a more detailed survey.

The correct position angle of the polarizing filter was determined visually by a preliminary observation of the comet, and the filter was rotated through 90° between the successive exposures, which were given separately on Kodak *O* 800 plates. It had been intended to give an exposure time of 2 hr. in each instance; but the presence of clouds limited the exposure through the 'crossed' filter to 1 hr. 20 min. The mean altitude of the comet was approximately 20°.

Both plates were microphotometered; and the photographic density measures at each of the three selected locations were reduced by the aid of magnitude–density curves, based on measurements of the trailed images of five field stars, namely, *H D*, 21291, 21389, 21447, 25291 and 25642. No corrections were applied to the observed magnitudes for differential atmospheric extinction.

The following values of percentage polarization were obtained: in the brightest part of the coma, 41 ± 5 per cent; in the inner tail, at a point 4 min. of arc from the coma, 51 ± 5 per cent, and at a point 5 min. of arc distant, 35 per cent, with the plane of polarization along the radius vector to the Sun.

Because of under-exposure, the total density in the image of the tail recorded through the 'crossed' analyser equalled the threshold (sky background) value at an angular distance of only 7 min. of arc from the bright, central region of the coma. Thus the probable error of the third measurement given above is uncertain and, in consequence, this result should have less weight than the other two.

The amount of polarization found in the head of the comet agrees well with the value of 45 per cent obtained on an unspecified date by Richter[1], who also used a polarizing filter. However, it is nearly 20 per cent higher than the maximum polarization found by Blackwell and Willstrop[2] in the continuous spectrum of the comet.

Richter (*loc cit.*) has reported that the comet's tail was also 45 per cent polarized out to a distance of 4° from the head. The present results suggest that this value may even be exceeded at the base of the tail near its junction with the coma.

D. R. Barber

Norman Lockyer Observatory,
University of Exeter,
Sidmouth, Devon.
Jan 29.

[1] *The Observatory*, 77, 131 (1957).
[2] *Mon. Not. Roy. Astro. Soc.*, 117, 590 (1957).

The α-β Transformation in Keratin

The possibility of obtaining from X-ray diffraction results a quantitative estimate of the course of the α–β transformation as a keratin specimen is stretched is so important that attempts such as that of Bendit[1] are to be welcomed. I feel, however, that it is impossible to say the same about the proposal recently put forward by V. D. Gupta[2], who measures for specimens at various extensions the value of an index

$$\Omega = \frac{I_e - I_m}{I_e + I_m} \times 100$$

which he wishes to take as a measure of what he calls the "degree of order". So far as can be gathered from his somewhat ambiguous phraseology, the quantities I_m and I_e are the intensities of the meridional and equatorial diffraction spots, the former the group of reflexions with spacings near 5·1 A., and the latter the reflexions with spacings near 10 A. (common to the α- and β-photographs) and near 4·65 A. (characteristic of the β-photograph). If this interpretation of Gupta's intentions is correct, then changes in Ω are indications not so much of changes in the degree of order (whatever this might mean) as of changes in the β : α ratio. His conclusion that during stretching there is an initial rapid rise in the degree of order, with little further change at extensions greater than 40 per cent, should therefore be replaced by the almost trivial result (it was not so trivial 30 years ago) that the X-ray photograph at 40 per cent extension is more like that at 70 per cent extension than it is like that of unstretched fibres.

To talk about "degree of order" in a material like keratin, with its potentialities for changes of crystal structure, state of crystallite orientation, and crystallinity ratio, without making it quite clear whether some or all of these or some other unspecified characteristic of the material is involved, is, we consider, dangerous and misleading. If, for example, we agree to measure lack of order by the entropy, experiments on the elastic properties[3] indicate that in the initial stages of extension there is a *decrease* in the degree of order; I think that this is confirmed when the results of X-ray diffraction experiments are properly interpreted.

H. J. Woods

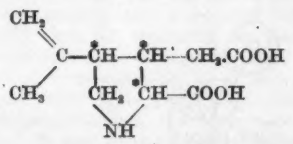
Textile Physics Laboratory,
Dept. of Textile Industries,
University of Leeds.

[1] Bendit, E. G., *Nature*, 179, 535 (1957).
[2] Gupta, V. D., *Nature*, 181, 113 (1958).
[3] Woods, H. J., *J. Colloid Sci.*, 1, 407 (1946).

Structure of Kainic Acid and its Isomer, Allokainic Acid

In 1953, Murakami, Takemoto and their collaborators[1] isolated the most active component of *Digenea simplex* Agardh which has been well known as an anthelmintic (vermifuge) for more than a thousand years. They named it kainic acid after 'Kaininso', the Japanese name of the mother alga. Kainic acid, $C_{10}H_{15}O_4N$, has an intense anthelmintic effect, about ten times that of santonin, without side-effects. In conjunction with chemical studies[2] to determine the structure of this interesting compound, we have carried out a structural determination by means of X-ray crystal analysis.

Following orthodox X-ray procedure the research was commenced with a salt containing zinc as a heavy atom. Zinc kainate crystallizes with two molecules of water in colourless prisms, which are orthorhombic. The space group was found to be $P2_12_12_1$, and the dimensions of the unit cell, containing four units of $C_{10}H_{15}O_4N\ Zn.2H_2O$, were as follows: $a = 25{\cdot}50$, $b = 6{\cdot}93$, $c = 7{\cdot}60$ A. By the trial-and-error method based on the presence of the heavy atom, electron-density projections along the *b*- and *c*-axes were derived, and the structure of kainic acid was found to be 2-carboxyl-3-carboxymethyl-4-*iso*propenylpyrrolidine, with the stereoconfiguration shown in the structural formula (asymmetric centres are marked by asterisks):



The structure of the molecule in the zinc salt is illustrated schematically in Fig. 1, where it is viewed along the *b*-axis.

In addition, we examined kainic acid itself. From water, kainic acid crystallizes with one water molecule, in colourless needles which are monoclinic. The dimensions of the unit cell were as follows: $a = 12{\cdot}07$, $b = 5{\cdot}86$, $c = 8{\cdot}19$ A., $\beta = 94{\cdot}7°$. The space group was $P2_1$, and the unit cell contained two units of $C_{10}H_{15}O_4N.H_2O$. By trial-and-error methods the electron-density projections along the three principal crystal axes were obtained, and the result was in

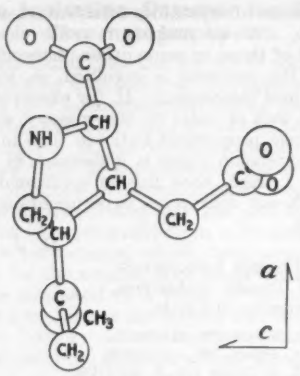


Fig. 1. The structure of the kainate anion

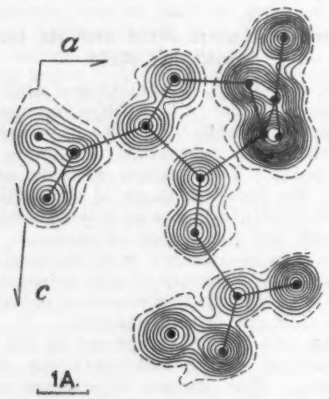


Fig. 2. The electron density of kainic acid monohydrate, projected on (010)

agreement with that for the zinc salt. The *b*-axis electron-density projection is shown in Fig. 2.

Furthermore, we analysed an isomer of kainic acid, allokainic acid, which is found also in *Digenea simplex* Agardh. It is weakly anthelmintic, if at all. Crystalline allokainic acid forms colourless prisms with no water of crystallization; the space group is $P2_12_12_1$, and the four units of $C_{10}H_{15}O_4N$ are contained in a cell of dimensions: $a = 26{\cdot}08$, $b = 5{\cdot}83$, $c = 6{\cdot}95$ A. The electron-density projections along the *b*- and *c*-axes were derived by the trial-and-error method. The stereochemical structure of the molecule is represented in Fig. 3, viewed along the *b*-axis. The structural relationship between the two isomers can be seen by comparison with Fig. 1. Accordingly, allokainic acid can be said to be a stereoisomer of kainic acid, differing merely in the configuration of one of its side-chains, namely, by reversal of the configuration at C_4 of the pyrrolidine ring. It is of interest that the anthelmintic effects of the two isomers are remarkably different from each other, due, apparently, to the dissimilar configurations of the *iso*propenyl side-chain.

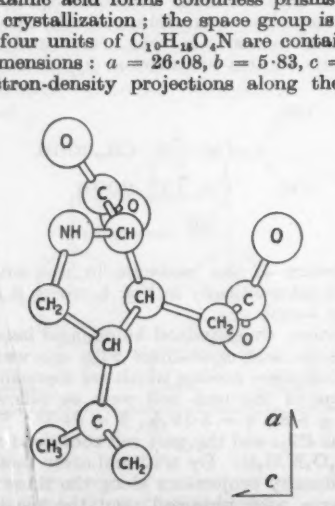


Fig. 3. The structure of allokainic acid

These X-ray results completely coincided with the conclusions[2] deduced from the chemical behaviour. This work will shortly be published in detail in the *Bulletin of the Chemical Society of Japan*.

I. Nitta
H. Watase
Y. Tomiie

Department of Chemistry,
Faculty of Science,
University of Osaka.
Osaka. Oct. 22.

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Colour Filters for the 4358-A. Line of the Mercury Discharge Spectrum

In connexion with other work[1], experiments have been carried out with the aim of obtaining an improved filter for the 4358-A. line of the mercury discharge spectrum which is of interest for photochemical and spectroscopic investigations.

We have found that a solution filter consisting of 9 : 10-dibromoanthracene (or 9 : 10-dichloroanthracene) and of crystal violet perchlorate in suitable concentrations and solvents will separate the 4358-A. line with a transmission of 80 per cent almost completely from all other lines of the mercury discharge lamp, including that of the intense neighbouring 4047-A. line.

Table 1 shows transmission data for various concentrations and thicknesses in ethanol–toluene solution (measured against air, if not otherwise stated).

Probably the most suitable filter containing 0·0125 per cent crystal violet perchlorate and 0·02 per cent 9 : 10-dibromoanthracene has a transmission in a 1-cm. cell measured against air at the mercury lines of 5790 ($<10^{-10}$), 5461 ($<10^{-10}$), 4358 (81 per cent), and 4047 A. ($<10^{-4}$). Reflexion losses at 4358 A. represent an appreciable part of the transmission losses and are slightly greater if the solutions of the perchlorate and of dibromoanthracene are kept in separate cells. No precautions have been taken for their reduction. The pass-band (width of band at twice the intensity observed at 4358 A.) is 325 A. (against air) and 260 A. (against cell and solvent). This may be compared with the 42 and 1 per cent transmissions at 4358 and 4047 A., respectively, and with the pass-band of approximately 500 A. for the best copper salt/sodium nitrite filter suggested elsewhere[2] and the <5 per cent transmission at 4358 A. of the commercial filters available.

Table 1. Transmission Data for Filter containing Crystal Violet Perchlorate and 9 : 10-Dibromoanthracene in Ethanol and Toluene

Crystal violet perchlorate (per cent)	9 : 10-Dibromoanthracene (per cent)	Solvent	Cell	Per cent transmission at λ, A. 5790	5641	4358	4047
0·025	0·02	Ethanol/toluene (1 : 1)	2 cm.	0	0	58	0
			1 cm.	0	0	72	0
			5 mm.	0	0	83	~0·1
			2 mm.	< 0·01	< 0·01	85	4
0·0125	0·02	Ethanol/toluene (1 : 1)	2 cm.	0	0	72	0
			1 cm.	0	0	81	0
			5 mm.	0	0	83	~0·1
			2 mm.	< 0·01	< 0·1	85	6
			1 cm.	0	0	88	0*
0·00625	0·02	Ethanol/toluene (1 : 1)	2 cm.	0	0	76	0
			1 cm.	0	0	83	0
			5 mm.	0	0	84	~0·1
			2 mm.	1·3	4	89	6
0·0125	—	Ethanol	1 cm.	0	0	78	0
—	0·02	Toluene	1 cm.				
0·0125	—	Ethanol	1 cm.	0	0	82	0*
—	0·02	Toluene	1 cm.				

* Measured against cell and solvent.

The light fastness of these filters has been investigated by exposure to the G.E.C., 400-W. Osram[3] and the very intense B.T.H., 240-W. Mazda lamp[4]. The cells containing the filters were sealed to prevent evaporation and to keep atmospheric oxidation to the minimum.

Table 2 shows the transmission changes of the filter in ethanol–toluene solution on irradiation in various conditions. The light fastness is particularly satisfactory when a sealed cell containing dibromoanthracene in toluene is placed in front of one containing crystal violet in ethanol.

Table 2. Change in Transmission on Irradiation

Filter	Cell	λ, A.	Per cent transmission after exposure (0)	Osram (20 hr.)	Mazda (6 hr.)
0·0125 per cent crystal violet and 0·02 per cent 9 : 10-dibromoanthracene in ethanol/toluene (1 : 1)	1 cm.	5790	0	0	0·2
		5461	0	0	2
		4500	67	62	68
		4358	81	71	71
		4200	62	61	58
		4047	0	0	0
0·0125 per cent crystal violet in ethanol	1 cm.	5790	0	0	0
		5461	0	0	0
0·02 per cent 9 : 10-dibromoanthracene in toluene	1 cm.	4500	57	56	57
		4358	78	77	75
		4200	54	56	51
		4047	0	0	0

The investigation has been carried out with the help of a research grant from the Paul Fund of the Royal Society, which is gratefully acknowledged.

A. Burawoy
A. G. Roach

College of Science and Technology,
Manchester, 1. Jan. 7.

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Agar as Specimen Carrier in Double-Beam Infra-Red Spectroscopy

Methods for preparing specimens for infra-red spectroscopy are limited. A workable addition to the few techniques available should extend the usefulness of infra-red spectroscopy.

Pollen polysaccharides prepared by the Bencard Allergy Research Unit gave films too brittle to be transferred from the base on which they were dried when prepared by the method of Orr[1,2]. To prepare them for infra-red spectroscopy one of us (J. G. F.) adapted a method previously reported for preparing films of antigen–antibody precipitation patterns in agar[3]. The polysaccharides were incorporated in an agar gel which was afterwards dried to a film. Films for spectroscopy have been made by others from gelatine[4], polystyrene[5] and polyethylene[6].

An approximately 0·8 per cent stock agar is made from 'Oxoid *L*.10', thoroughly clarified by a previously published method[7] and the gel dialysed by soaking in several changes of distilled water. This appears to remove a band of unreproducible intensity in the 4·9μ region. Material for infra-red examination is dissolved or suspended in distilled water in suitable concentration and mixed with an equal volume of melted stock agar cooled to about 56° C. 2 ml. of the agar-specimen mixture is pipetted on to a siliconed glass plate, for example, a lantern slide cover glass, and spread out to cover the area within a 1½-in. internal diameter metal or plastic ring. Simultaneously, a control film is prepared in the same way with distilled water.

The agar is allowed to gel, the gels are cut free of the rings with a sharp-pointed blade, the rings removed and the plates with the gel disks air-dried overnight at 37° C. The dried films are coherent and can be lifted from the siliconed glass surface for mounting in cell holders. A film may be cut to a desired size by placing a lead spacer or suitably sized disk on it and ringing with a pointed blade. Alternatively, they can be mounted on annular linen gummed reinforcements of suitable size, care being taken to avoid contaminating or straining the film.

When made with non-crystallizing substances, for example, polysaccharides, the films are clear and transparent. When crystallization occurs, for example, with glycine and urea, it does not hinder spectroscopic examination. Films have also been prepared from substances in suspension, such as micro-organisms.

Agar films (Fig. 1) were examined in the Grubb Parsons double-beam spectrometer. Adequate cancellation of the agar spectrum and uniformity of optical density, as checked by film rotation, can be obtained if the films are dried under the same conditions.

Differences in spectra associated with methods of preparation and presentation of samples are recognized occurrences. The spectra for substances in agar

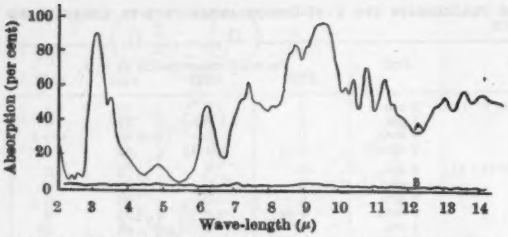

Fig. 1. Infra-red spectra of agar films. *A*, uncompensated single film; *B*, difference spectrum of two films

films are characteristic of the method and reproducible, though differing in some details from those in potassium bromide disks (Fig. 2). Thus, in agar gel films the glucose spectrum loses some of its fine structure (also observed by Kuhn[6] in his vacuum-dried sugar preparations), and there is a reversal of the relative intensities of the 10·9μ and 11·2μ glycine bands.

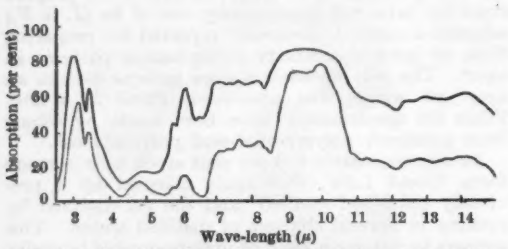

Fig. 2. Infra-red spectra of timothy grass pollen polysaccharide. ····, agar films; ——, potassium bromide disk

As the agar gel film technique is directly applicable to dissolved or suspended substances it may be particularly useful for process analysis and control.

No attempt has been made to control the water content of the films beyond the initial drying, but recent[9,10] observations on the effect of water content on infra-red spectra should be considered.

We wish to thank Mr. D. F. Lawson for photographing the spectra.

J. G. Feinberg
H. D. C. Rapson
Mary P. Taylor

Beecham Research Laboratories,
Brockham Park,
Betchworth, Surrey.

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A Rotating Hanging Mercury-Drop Electrode

The work of Gerischer[1] and Delahay *et al.*[2] suggested to us the use of the hanging mercury-drop electrode as a rotating electrode. This electrode, used as a stationary electrode (as proposed by Ross *et al.*[3]), offers several distinct advantages over the conventional dropping-mercury electrode. The charging current is largely reduced, the current-voltage curve can be scanned in a shorter time and the curve-distorting oscillations are eliminated. However, used as a rotating electrode its advantages are even greater. The electrode owes its greater sensitivity to the accelerated diffusion of reducible species (thinner diffusion layer). Peak-formation in the current-voltage curve is prevented, because depletion of the reducible species in the diffusion layer of the electrode cannot occur. If desired, the curve can be plotted manually: it resembles the polarogram in its ideal form. Analysis of multicomponent systems offers none of the extra difficulties encountered with the stationary type[3], and compensation of the diffusion current of a more noble metal ion, preceding the diffusion current of the metal ion to be determined, is therefore possible. The reproducibility of repeated determinations on the same solution is comparable to or better than that of conventional polarography. It is possible to determine concentrations of reducible ions as low as 10^{-7} *M*.

Fig. 1 shows the cell and the rotating electrode. The saturated calomel electrode is connected to the cell by means of a salt bridge containing a 3 per cent agar gel, saturated with potassium chloride; the end of the bridge also functions as stopper.

The cell is thermostated at 25·0 ± 0·1° C. Nitrogen may be either bubbled through or passed over the solution (when recording) through stopcock *K*. Details of the electrode are also shown in Fig. 1: the platinum wire (diameter, 0·5 mm.; length, 0·5 mm.) projecting from the end of a soft-glass tube is thinly plated with gold. Two drops of the conventional dropping-mercury electrode type can readily be attached to the plated platinum electrode and adhere even when the electrode is rotated at a speed of 750 r.p.m., provided the tip of the electrode is on the axis of rotation. A constant speed of rotation is necessary to obtain a constant diffusion current. The hanging mercury-drop electrode can be reproduced easily if necessary.

An example of a current-voltage curve of a two-component system (10^{-4} *M* Pb++ and 10^{-4} *M* Cd++

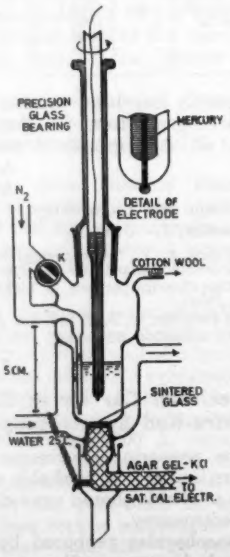

Fig. 1. Voltameter cell with detail of electrode

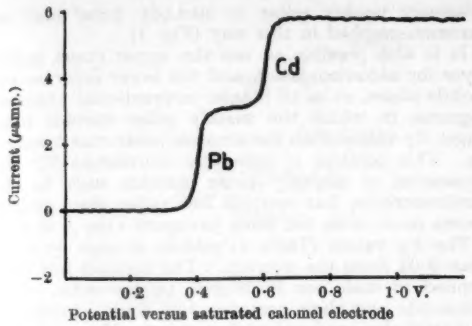

Fig. 2. Current-voltage curve of a two-component system (10^{-4} *M* Pb^{++} and 10^{-4} *M* Cd^{++} in 0·1 *M* potassium chloride at *c.* 500 r.p.m.)

in 0·1 *M* potassium chloride) is shown in Fig. 2. The voltage-scanning rate was equal to that commonly used in conventional polarography.

Further details of this electrode, which appears to be a useful analytical tool, will be published elsewhere. Since this communication was written, our attention has been directed to recent work by Delahay *et al.*[4] in which he used a rotating electrode in voltameter studies of anodic stripping.

E. Barendrecht

Central Laboratory,
Dutch State Mines,
Geleen.
Dec. 19.

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Detection of Triterpenoid Acids on Paper Chromatograms

In the course of an investigation of triterpene acids from natural sources it was necessary to devise tests for the detection of these compounds on alumina-impregnated filter paper.

A very convenient method is to spray the filter paper with a solution of phosphotungstic acid. Noller's reaction[1] has been used for the detection of triterpenoid compounds on filter paper; the Neher and Wettstein test[2] is also suitable for this. After spraying the paper chromatogram of triterpene acids with a solution of goat's blood[3], hæmolysis was observed.

The procedure is as follows. The paper chromatogram after development with the solvent is thoroughly dried by a current of hot air. It is next sprayed with a 25 per cent solution of alcoholic phosphotungstic acid and dried carefully for 2 min. in an oven kept at about 115–118° C. The paper then showed well-defined coloured spots against a white background; 3–5 μgm. of each component acid could be detected on the chromatogram.

The demonstration of triterpene acids on a paper chromatogram is also possible after treatment by the modified Noller reaction. Quantities of triterpene acids of about 5 μgm. on paper can be detected successfully after drawing the strip through a solution of 1 per cent anhydrous stannic chloride in pure thionyl chloride and heating it for 60–80 sec. at 85–90° C. Spots of different colours are obtained with the triterpene acids.

Table 1. Colours of Spot Tests for Triterpene Acids

Substance	Alcoholic phosphotungstic acid (25 per cent)	Stannic chloride in thionyl chloride (1 per cent)	Zinc chloride in benzoyl chloride
Poliporenic acid *A*	Orange	Orange	Blue-purple
Glycyrrhetinic acid	Yellow-brown	Yellow-brown	Yellow-brown
Ursolic acid I	Pink-purple	Pink→violet	Pink→violet→blue
Betulinic acid	Brown-violet	Yellow-violet	Yellow-brown
Oleanolic acid	Pink-purple	Pink→violet→blue	Pink→violet→blue

For the hæmolysis test, a solution of defibrined goat's blood in normal saline (1 : 8) is used. After spraying, the triterpene acids appeared as lighter spots on a tan background. In some cases, the spots become more distinct after the paper has dried and occasionally they were more readily discernible in transmitted light.

For the detection of triterpene acids on alumina-impregnated filter paper Gross's[4] and Belic's[5] reagents can be used. However, these reactions are not so useful in practice. Full details of this work will be published in *Chemia Analityczna* (Poland).

B. Pasich

Department of Pharmacognosy,
Pharmaceutical Faculty,
Medical Academy,
Poznań.
Oct. 14.

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Qualitative, Quantitative and Preparative Chromatography of Steroids on Fully Acetylated Paper

The majority of methods developed for the paper chromatographic separation of steroids involve impregnation of the paper with a relatively polar, non-volatile liquid, such as propylene glycol, formamide or 'Phenylcellosolve', a less polar liquid being used as the mobile phase. Some 'reversed phase' techniques have also been applied, in which the paper is rendered hydrophobic by impregnation with 'Quilon', paraffin oil, kerosene or silicone and the mobile phase is a relatively polar liquid. Impregnation of the paper is usually difficult to carry out in a reproducible way and therefore R_F values may depend on slight experimental variations. Moreover, impregnation with a non-volatile liquid may interfere in quantitative determinations.

Chromatography on acetylated paper has the advantage of requiring no such impregnation. The separation of various substances on partially acetylated paper has been described by several authors[1]. It is, however, difficult to obtain a homogeneous

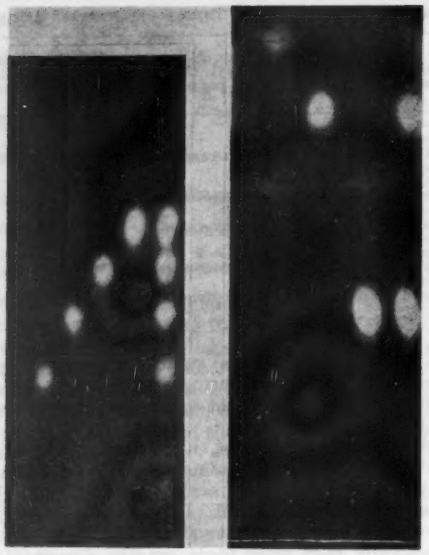

Fig. 1. Method *B*

Fig. 2. Method *C*

Key: 1, Δ^4-Cholesten-3-one; 2, progesterone; 3, 17α-hydroxyprogesterone; 4, Reichstein's compound *S*; 5, hydrocortisone; *m*, mixture. Detection: sodium hydroxide fluorescence in ultraviolet (ref. 4)

partially acetylated paper and therefore irreproducible results are obtained. Recently, Zijp[2] described the identification and quantitative determination of rubber-antioxidants on fully acetylated paper, which is much more homogeneous.

We have obtained good separations of various groups of steroids on fully acetylated Whatman 1 paper, prepared by Zijp's method[3]. At first a one-phase mixture of benzene, methanol and water (1 : 10 : 3) was used as the mobile phase. Accommodation is not required in this case. The method is simple and quick, and reproducible R_F values are obtained, but some 'tailing' is usually observed (method *A*).

To prevent this, a two-phase mixture of benzene, methanol and water (4 : 4 : 1) was used, the lower layer (mainly benzene) being used for accommodation and the upper layer (mainly methanol) as the mobile phase (method *B*). A wide range of steroids from relatively weakly polar to strongly polar may be chromatographed in this way (Fig. 1).

Table 1. R_F Values of Steroids after Chromatography on Fully Acetylated Paper

Steroid	Method *A*	Method *B*	Method *C*
Testosterone acetate		0·27	
Δ^4-Androstene-3,17-dione		0·41	
Testosterone		0·57	
Progesterone		0·35	0·92
Deoxycorticosterone		0·45	0·80
17α-Hydroxyprogesterone		0·47	0·78
Reichstein's compound *S*		0·57	0·61
Cortisone		0·60	0·46
Hydrocortisone		0·68	0·39
Δ^4-Pregnen-3β-ol-20-one		0·40	
Deoxycorticosterone acetate		0·30	
Cortisone acetate		0·43	
Hydrocortisone acetate		0·51	
Deoxycholic acid	0·64		
Cholic Acid	0·74		
Cholesterol	0·33	0·10	
Δ^4-Cholesten-3-one	0·28	0·07	
7α-Hydroxycholesterol	0·59	0·38	
Δ^4-Norcholesten-3β-ol-25-one	0·42	0·31	

It is also possible to use the upper (most polar) layer for accommodation and the lower layer as the mobile phase, so as to obtain 'conventional' chromatograms, in which the weakly polar steroids have larger R_F values than the stronger polar ones (method *C*). This method is especially convenient for the separation of strongly polar steroids such as the corticosteroids, but steroids less polar than progesterone move with the front (compare Figs. 1 and 2).

The R_F values (Table 1) seldom diverge by more than 0·02 from the average. The method has been applied to male sex hormones, progesterone, corticosteroids and their acetates, bile acids, cholesterol and oxidation products of cholesterol. The ascending technique was used in all cases.

The same phase system may also be used for preparative purposes. Good separations have been obtained with thick paper (fully acetylated Whatman 3 *MM*) and with columns of paper disks or 'chromatopiles' (Schleicher and Schüll 2043 *a*, *vollazetyliert*). Experiments with columns of cellulose triacetate powder were somewhat less successful.

The quantitative determination after elution from the chromatogram and spectrophotometric evaluation at 242 mμ with respect to 240 mμ, showed that 80–120γ of cholestenone and progesterone may be determined with a relative error of less than 5 per cent.

A detailed report of this work will be published elsewhere.

F. J. Ritter
J. Hartel

Centraal Laboratorium T.N.O.,
Delft.
Oct. 11.

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A Modified Technique in Chromatography

The methods usually adopted for the chromatographic separation of inorganic radicals on filter paper or an adsorbent column lead to the formation of coloured zones with diffusion fronts which are distorted and irregular. We have now developed a method for obtaining sharp, straight and evenly coloured bands for each one of the radicals separated. Strips of Whatman filter paper (No. 1), are dipped in a hot agar sol (2–4 per cent) containing reagents which react with the radicals to be tested. The strips are then removed from the agar sol and the excess sol drained off, leaving a thin layer of the sol on the surface of the paper, which solidifies to a gel on cooling. The paper strip thus prepared is then immersed to a height of 5 mm. in an aqueous solution containing the radicals to be tested (the concentration of the solution being 0·1 *N* with respect to each ion). As the electrolytes diffuse into the agar-gel impregnated filter paper containing the appropriate reagents, sharp, straight zones of the characteristic coloured precipitates are produced. When the layer of the gel coating on the paper is thick, these coloured bands show a fine structure due to Liesegang ring formation. In a run of four hours, bands of sufficient width for accurate measurement with a travelling

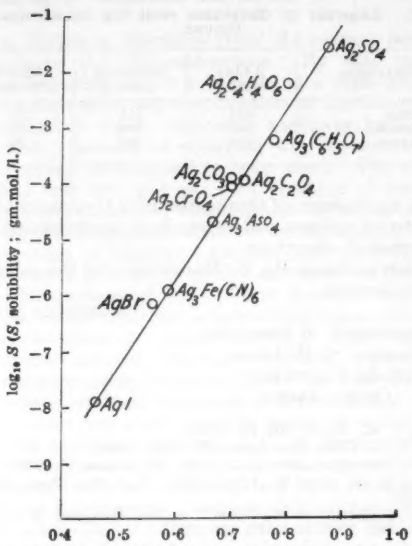

Fig. 1

microscope are produced in accordance with the solubility-product principle discussed previously[1].

Apart from the fact that a beautiful coloured band 'spectrum' is produced, the quantitative study of these bands has revealed a simple and striking relationship between d, the distance of the diffusion front of each band after a certain time from the starting point of diffusion, that is, the surface-level of the solution in which the gel-coated paper is dipped, and S, the solubility of the corresponding precipitate, namely :

$$d = a + b \log_{10} S$$

where a and b are constants. The validity of this relationship is brought out by the results represented graphically in Fig. 1.

Similar results have been obtained by allowing the electrolytes in the solution to diffuse for about six to eight hours into an agar gel layer containing the reagents spread on a glass slide. We have further observed that, when the gel layer is sufficiently thick (say 3–4 mm.), the individual coloured bands corresponding, for example, to lead, silver and copper chromates show a fine structure owing to their resolution into closely spaced lines corresponding to the Liesegang rings (see Fig. 2). The picture thus obtained is similar in appearance to an optical band spectrum viewed at high resolution.

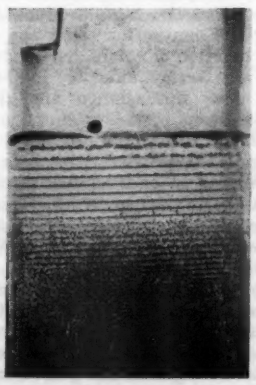

Fig. 2

We have thus worked out a new technique of chromatographic separation of inorganic ions, which also gives a new and simple method for the determination of the solubilities or solubility-products of various sparingly soluble substances. By this method we can separate the various hydrated ions in solution by their sizes ; for ions which on hydration have smaller sizes diffuse farther than those which, owing to their larger size, diffuse more slowly in accordance with the well-known diffusion equation.

In a previous communication[2] we have described a new method of determining the solubility products of sparingly soluble substances by means of the relation $\Delta v_\infty = c - b \log_{10} S$, where Δv_∞ is the limiting increase of volume observed on mixing dilute aqueous solutions of two electrolytes leading to the formation of the precipitate, and S is the solubility product ; c and b are constants. The change of volume, Δv_∞, indicates the water of ionic hydration released during the combination of ions, and is greatest for precipitates having the lowest solubility. Comparison of these results with those given earlier in this communication shows that the most insoluble inorganic precipitates are formed from hydrated ions having the largest size (including water of hydration), which consequently diffuse most slowly and produce the band in the 'chromatogram' nearest the surface of the electrolyte solution.

K. Krishnamurti
B. V. Dhareshwar

Chemical Laboratories,
College of Science,
Nagpur, India.

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A Solvent for the Paper Chromatographic Separation of Glucose and Sorbitol

Glucose and sorbitol can be separated by paper chromatography in 7 hr. by means of a solvent mixture which is composed of nine parts (by vol.) of ethyl methyl ketone, one part glacial acetic acid and one part of water saturated with boric acid.

This solvent was elaborated because, of the many solvent mixtures described for the paper chromatography of sugars, none appeared to be particularly effective for the separation of these two substances.

We use the descending technique in chromatography jars held at a constant temperature of 22° C. Whatman No. 54 paper gives rather better results than Whatman No. 1 ; separations with this latter paper are also somewhat slower. The solvent has given good results in this laboratory for some two years.

The rates of movement of sorbitol and some other sugars on No. 54 paper, as compared with glucose ($R_G = 1{\cdot}0$), are shown in Table 1.

Table 1

Sugar	R_G	Sugar	R_G
Sorbitol	3·0	D-Xylose	2·9
Mannitol	2·5	D-Ribose	7·0
D-Fructose	1·9	Maltose	0·2
D-Arabinose	2·0		

We wish to thank Prof. F. G. Gregory and Dr. H. K. Porter for their encouragement and interest in this work.

W. R. Rees*
T. Reynolds

Research Institute of Plant Physiology,
Imperial College of Science
and Technology,
London, S.W.7.
Dec. 16.

* Present address: Department of Chemistry, The University, Glasgow, W.2.

Chromatographic Separation of Œstriol, Œstrone and Œstradiol-17β

Non-ionic adsorption of aromatic substances on ion exchange resins discussed by D. E. Weiss[1] has been successfully utilized by me for the chromatographic separation of aromatic compounds, for example, alkylated phenols[2] and N-2 : 4-dinitrophenylamines[3], on the column of carboxylic acid type cation exchange resins, 'Amberlite *IRC*–50' and 'Duolite *CS*–101' (*H* form). The technique has now been extended to the chromatographic separation of œstrogens using partially esterified carboxylic acid type cation exchanger as adsorbent. About 30 ml. of 'Amberlite *IRC*–50' (*H* form : 200–300 mesh, screened wet in sodium ion form[4]) was boiled with 400 ml. of the mixture of ethanol and *N* hydrochloric acid (2 : 1 by vol.) for 40 hr. This partially esterified resin was washed with the mixture of ethanol and water (3 : 2 by vol.) and suspended in two volumes of the same mixture. The suspension was poured into a chromatographic tube and allowed to settle under gravity. A column 0·8 cm. in diameter and 62 cm. in height was used. Œstrogens were dissolved in the same solvent as that used for the packing of the column. 1 ml. of the solution was placed on the column and allowed to drain under gravity. Elution was performed with the same solvent and the effluent was collected in fractions of 40 drops. The ultraviolet absorption was measured at 280 mμ using a Beckman *DU* quartz spectrophotometer and plotted against fraction number (Fig. 1). The elution sequence was similar to that of reversed phase partition chromatography[5], the most polar component being eluted first. Recovery from the column was satisfactory and the elution pattern was reproducible. Since the condition of the column is unchanged after chromatography, the column can be used many times

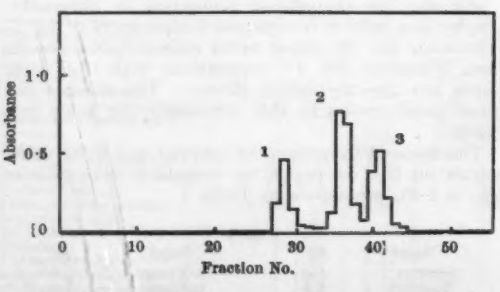

Fig. 1. Elution curve of œstrogens. 1, Œstriol; 2, œstradiol-17β; 3, œstrone. Flow-rate, 2 drops per min.; room temperature, 20° C.

Table 1. Recovery of Œstrogens from the Chromatographic Column

Œstrogens	Added (μgm.)	Recovered (μgm.)	Recovery (Per cent)
Œstriol	414	413	100
Œstradiol-17β	855	840	98
Œstrone	606	553	92

The application of this method for the quantitative analysis of urinary œstrogens is in progress and will be reported elsewhere.

I wish to thank Mr. K. Matsumoto for the generous gift of œstriol.

Tokuichiro Seki

Department of Genetics,
Faculty of Medicine,
Osaka University,
Osaka, Japan.

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Determination of Epinephrine and Related Compounds on Paper Chromatograms

The most sensitive chemical method for determining epinephrine in solution is the reaction with ethylenediamine. The reaction yields a number of products, several of which are fluorescent. These substances can be used for quantitative measurement. Nor-epinephrine produces a fluorescence of different colour so that mixtures of the two compounds can be determined by the selection of appropriate filters in measuring the fluorescent light[1].

The number of products formed in this reaction was determined by chromatographing the products produced by the interaction of the diamine and various catechols. This was done on paper by using as solvent 5 per cent ammonium hydroxide and *n*-propanol (9 : 1). There are three to five fluorescent pigments (depending on the conditions of the reaction) and several coloured but not fluorescent ones. We have observed that epinephrine yields some products different from those given by nor-epinephrine, but under these conditions of chromatography the products from catechol, nor-epinephrine, hydroxytyramine and epinine migrate similarly. Also, adrenochrome produces the same products as adrenaline, supporting the contention[1] that the catechol–ethylenediamine reaction involves oxidation.

The addition of ferricyanide or iodine to the ethylenediamine does not change the qualitative nature of the fluorescent pigments, but does increase the amounts formed. Presumably by rapid oxidation of the catechol, one can prevent other side reactions which decrease the yield of fluorescent compounds. This was the reasoning used in making this reagent.

Potassium ferricyanide (0·1 per cent in 5 per cent aqueous ethylenediamine) or iodine (0·01 *N* in 5 per cent aqueous ethylenediamine) are most useful as oxidizing agents. The alkaline iodine solution is stable (room temperature) for only a few days, whereas the ferricyanide solution is considerably more stable (weeks). After spraying with either of these solutions, the chromatograms are placed in an oven at 50° C. for 5 min. We have used the light produced

by a 'Sylvania Blacklite Blue' fluorescent lamp for examining the chromatograms. By this method, one can readily detect 0·05 μgm. of a catecholamine.

For the quantitative evaluation of the fluorescence considerably more elaborate methods have been evolved. Instead of spraying the chromatograms, the dipping technique has been used. The strip is dipped first into a 1 per cent solution of iodine in carbon tetrachloride, blotted, and before it is completely dried, dipped into a 1 per cent solution of ethylenediamine in *iso*propyl alcohol, and again blotted. The strip is then hung to dry at room temperature. The fluorescence of epinephrine appears within 30 min. whereas that due to nor-epinephrine and other catecholamines is much slower. The maximal difference between background and epinephrine fluorescence occurs in about 24 hr. At that time, the strips were scanned by means of a mechanical device which pulls the strip past the beam of a Beckman *DU* photometer equipped with a photomultiplier tube. The output of the photocell is recorded on a strip chart recorder. The 417-mμ light produces the maximal fluorescence. The exciting light is removed from the beam by a Corning colour filter 4015. The areas under the peaks are related to amounts of catecholamines by the use of a standard curve[2].

For example, 1 μgm. quantities of epinephrine were placed on four one-inch strips of Whatman 1 paper and chromatographed using *t*-butanol/formic acid/water (40 : 1 : 10) as the solvent. After 40 hr. (strips were cut so that the solvent dripped from the end) the strips were dried and treated as described above. Under these conditions, areas of 132, 130, 126 and 138 cm.^{2} were measured on the strip chart record of the fluorescence on these chromatograms. (It should be noted that the absolute areas have no significance as they are determined by the sensitivity of the photocell, the slit width, the brightness of the exciting beam, etc., as well as the amount of material on the chromatogram. Thus, it is necessary to compare the areas from the scans on unknown chromatograms with those on known amounts, using the identical conditions of scanning.) Using the most sensitive techniques (brightest exciting light, most sensitive position of the photocell) one can estimate 0·03 μgm.; for example, four chromatograms, prepared in the above way with 0·3 μgm., gave areas of 33, 41, 31 and 27 cm.^{2}.

George L. Ellman

Biochemical Research Laboratory,
The Dow Chemical Company,
Midland, Michigan.

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Coding Problem in Proteins

In a previous publication[1] a hypothesis was proposed to the effect that if a nucleic acid serves as a template for the linear array of amino-acids in a protein, it prescribes only the positions to be occupied by the aromatic amino-acids in that protein. It was postulated that the planar rings of the aromatic amino-acids would be differentially bound in cavities formed by two adjacent bases in such a way that the aromatic amino-acids with only six-membered rings (group 1) would occupy the space between two pyrimidines and those with five-membered rings (group 2) would occupy that between two purines. This hypothesis imposes certain restrictions on the arrangement of these amino-acids in proteins. It requires that, sandwiched between a pair of aromatic amino-acids belonging to the same group, there will be either none or an even number of non-aromatic amino-acids, and that an odd number will separate aromatic amino-acids of different groups.

Much progress has been made in recent years in the elucidation of amino-acid sequences in proteins, affording further test for the restrictions imposed by the hypothesis. Phenylalanine does not conform to this scheme, and its position must therefore be specified in some other manner. However, with regard to the other aromatic amino-acids, tyrosine (group 1) and histidine and tryptophan (group 2), the spacing between the aromatic pairs is of the order required by the hypothesis in each of the twelve cases reported where such a test is possible. These sequences are listed in Table 1. If any arrangement of aromatic amino-acids were permissible, the probability of obtaining this result attributable to chance alone would be very small.

Table 1. Amino-acid Sequences involving a Pair of the Aromatic Amino-acids

Insulin (refs. 2, 3)
-TYR-glu-leu-glu-asp-TYR-
-HIS-leu-cys-gly-ser-HIS-
-HIS-leu-val-glu-ala-leu-TYR-

Corticotropin (ref. 4)
-TYR-ser-met-glu-HIS-
-TRY-gly-lys-pro-val-gly-lys-lys-arg-arg-pro-val-lys-val-TYR-

Melanophore-stimulating hormone (ref. 5)
-TYR-lys-met-glu-HIS-

Glucagon (ref. 6)
-TYR-ser-lys-TYR-

Hypertensin (ref. 7)
-TYR-val-HIS-

Ribonuclease (refs. 8–10)
-TYR-pro-asp-ala-cys-TYR-
-TYR-lys-thr-thr-asp-glu-ala-lys-HIS-
-TYR-glu-ser-TYR-

Silk fibroin (ref. 11)
-TYR-pro-ser-TYR-

The non-randomness in the arrangement of the aromatic amino-acids offers support for the proposed coding system, although the lack of conformation of phenylalanine is a serious obstacle that must be overcome. It should be mentioned that phenylalanine stood apart from the other aromatic amino-acids even in the three protein sequences examined in the earlier paper. The observed restrictions suggest that the conclusion of Brenner[12], that "all amino sequences are likely to be found and that it will not be possible to effect a 'decoding' by discovering restrictions in sequences", may not be valid.

Drew Schwartz

Biology Division,
Oak Ridge National Laboratory*,
Oak Ridge, Tennessee.

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Specificity of Crystalline Saccharogenic Amylase of Moulds

Among the saccharogenic amylases of moulds hitherto reported, γ-amylase of *Aspergillus awamori* Kitahara[1], gluc-amylase of *Rhizopus delemar*[2] and taka amylase *B* of *Aspergillus oryzae*[3] seem to be the most characteristic in their mode of hydrolysing starch. All these amylases, belonging to the group of amylo-(1.4)-glucosidases suggested by Schubert[4], have already been purified to a certain degree and reported as being able to split glucose directly from starch. γ-Amylase, however, has been known to leave a limit dextrin when it acts on amylopectin and to show no maltase activity. Gluc-amylase has been reported to hydrolyse soluble starch in such way that with the iodine colour test of the reaction mixture the blue colour still remains even after the starch, calculated as glucose, is more than 90 per cent hydrolysed. The enzyme has also been found to hydrolyse amylopectin almost completely to glucose and to exhibit maltase activity. Taka amylase *B*, on the other hand, has been reported as being similar to γ-amylase in the hydrolysis of amylopectin, but exhibiting maltase activity.

Recently, we have obtained in a crystalline state the two saccharogenic amylases of *R. delemar*[5] and of *A. niger*, of which the specificity of the latter is very similar to that of taka amylase *B* (Figs. 1 and 2), starting from the enzyme preparation that was isolated as almost the pure enzyme solution by the Svensson and Brattsten paper electrophoresis apparatus with the flow system[6]. The two saccharogenic amylases were completely free from α-amylase and both showed a single boundary in an electrophoresis experiment. The two crystalline amylases formed glucose directly from starch and hydrolysed maltose. They exhibited neither transglucosylation activity on a substrate of maltose nor were they able to hydrolyse *iso*maltose and dextran. However, as shown in Fig. 3, these amylases were found to hydrolyse panose(4-*iso*-maltopyranosyl-D-glucose), in which glucose and maltose were formed, the latter being hydrolysed successively to glucose and no *iso*maltose was produced. As for the panose-hydrolysing activity, however, the saccharogenic amylase of *R. delemar* was much stronger than that of *A. niger*, at an equal level of their starch-hydrolysing activity. Another difference between the two saccharogenic amylases was found in the limit of hydrolysis of soluble starch and amylopectin. The saccharogenic amylase from *R. delemar* easily hydrolysed these substrates, converting them almost completely to glucose; on the other hand, that from *A. niger*

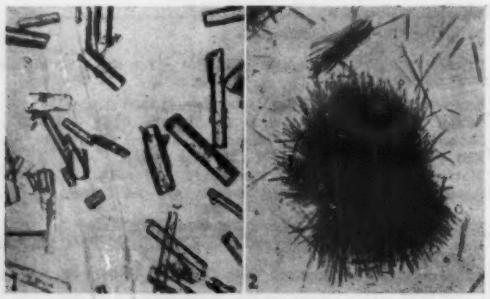

Fig. 1. Crystalline saccharogenic amylase of *R. delemar*
Fig. 2. Crystalline saccharogenic amylase of *A. niger*

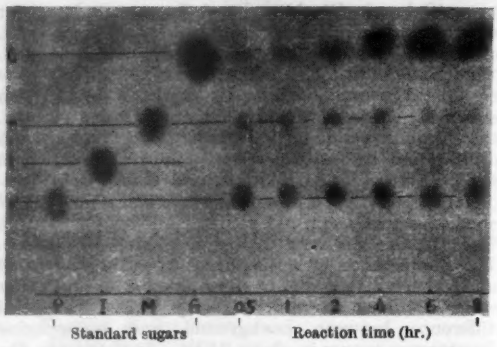

Fig. 3. Multiple ascending paper chromatogram of panose digests by crystalline saccharogenic amylase of *R. delemar*. Solvent, pyridine/butanol/water (2 : 3 : 1·5); standard sugars: *G*, glucose; *M*, maltose; *I*, *iso*maltose; *P*, panose

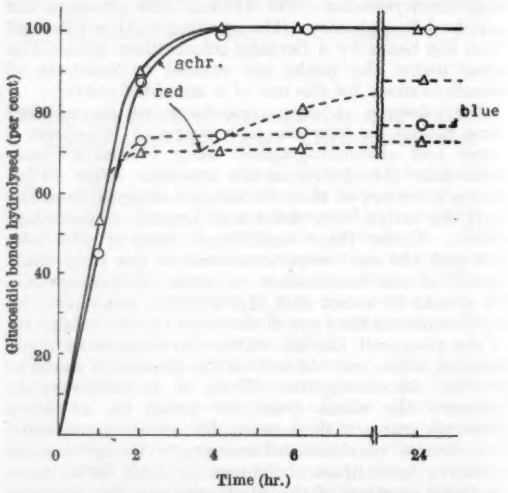

Fig. 4. Hydrolysis of soluble starch (○) and amylopectin (△) by saccharogenic amylases of *R. delemar* (solid line) and by *A. niger* (broken line). *Red* and *achr.* indicate the colour change of the reaction mixture from blue to red and to colourless respectively, by the iodine test. The long arrow indicates the addition of one thousand times the original amount of enzyme

converted about 75 per cent of soluble starch and about 70 per cent of amylopectin, and an extremely large amount of the enzyme was required to increase these degrees of hydrolysis (Fig. 4). The crystalline amylase from *R. delemar* hydrolysed several kinds of substrates with the initial velocities in the following decreasing order: glycogen, amylopectin, soluble starch, α-dextrin, amylose, panose and maltose.

Earlier, Underkofler[7] published an account of limit dextrinase, which appears to be consistent with that of taka amylase *B* of *A. oryzae*. Also, Yamasaki[8] and Ueda[9] have reported that the saccharogenic amylase system of *A. awamori* Kawachii completely hydrolyses several kinds of starches, and that the enzyme system consists both of saccharogenic amylases of *R. delemar* type and taka amylase *B* type. The limit dextrinase action or the ability to hydrolyse starch completely of such saccharogenic amylase as that of *R. delemar* might be explained by its powerful activity in hydrolysing panose, since amylopectin and its fission products by α-amylase appear to be

hydrolysed, at first to α-1.6-linked oligosaccharides of panose type on their non-reducing ends by the amylo-(1.4)-glucosidase action of the amylase, and the oligosaccharides formed therein to be further hydrolysed by this panose-hydrolysing action.

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YOSHIO TSUJISAKA
Osaka Municipal Technical
Research Institute,
JUICHIRO FUKUMOTO
TAKEHIKO YAMAMOTO
Institute of Polytechnics,
Osaka City University.

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Degradation of Steroidal Sapogenins to 16-Dehydropregnan-20-ones

THE need for improving the reactions whereby steroidal sapogenins, now in abundant supply, are transformed into pregnane derivatives has recently been re-emphasized[1]. Earlier publications have dealt definitively with the entire sequence, so that the original Marker procedure has now been improved at each stage[2].

A modification offered here converts the sapogenin to its corresponding 16-dehydropregnan-20-one acetate, generally in 50–75 per cent yield of isolable product, without the necessity of separating any intermediates or changing the character of the reaction medium along the way. For example, 88 gm. of tigogenin was heated 25 min. with 450 cm.^{3} of acetic anhydride; 30 gm. of pyridine hydrochloride was added and heating continued for 3 hr. The mixture was cooled to 15° C., diluted with 50 cm.^{3} of acetic acid and 79 cm.^{3} of water and stirred while adding 54 gm. of chromic anhydride in 500 cm.^{3} of 90 per cent acetic acid. The temperature was maintained at 16–20° C. After standing at 25° C. for 3 hr. the solution was treated first with 31·5 gm. of 36 per cent formaldehyde and then with 80 gm. of sodium acetate. The stirred suspension was heated on the steam-bath for 1 hr., cooled in ice and diluted gradually with 3,000 cm.^{3} of cold water. A white, granular precipitate was collected, washed and dried; it melted at 120–150° C., weighed 82·1 gm. and by ultra-violet absorption contained 73 per cent of the 16-dehydropregnane. It was adsorbed from benzene on to fifteen parts of silica gel and the product eluted directly with 5 per cent ethyl acetate in benzene to give 51·6 gm. or 68 per cent of 3β-acetoxy-16-dehydro-5α-pregnan-20-one (melting point 162–167° C., $\varepsilon_{max.\ (240\ m\mu)}$ 9,300 in methanol). When recrystallized twice from methanol, material of analytical quality (melting point 168·0–169·2° C., $[\alpha]_D$ 37·5° (chloroform)), $\varepsilon_{max.\ (240\ m\mu)}$ 9,460 (see ref. 3), was obtained in an overall yield of 45 per cent (value extrapolated from smaller sample).

In other instances the initial heating with acetic anhydride has been omitted; also with smaller quantities the usual ether extraction of the final mixture has been used. Thus, 20 gm. of a mixture of ruscogenin and its C_{25} epimer gave 20·6 gm. of extractable material of which 11·2 gm. (59 per cent yield) of the desired 16-dehydropregnane, a glass[4] ($\varepsilon_{max.\ (240\ m\mu)}$ 9,460) was obtained by direct elution with 5 per cent ethyl acetate. Hecogenin treated in the same manner yielded 59 per cent of crystalline 3β-acetoxy-16-dehydro-5α-pregnane-12,20-dione, (melting point 179–185° C.) from the eluates.

This method offers the advantages of speed and simplicity. It has been applied as a matter of routine to sapogenins and derivatives with uniform success.

G. P. MUELLER
Division of Chemical Research,
G. D. Searle and Company,
Skokie, Illinois.
July 15.

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A Rapid and Specific Method for the Isolation of Pneumococcal Polysaccharide

THE report by Gessler *et al.*[1] on the use of a completely substituted ethane (trichlorotrifluoro ethane, 'Genetron 113'; obtained from the Division of Allied Dye and Chemical Corp., General Chemicals, Inc., New York) as a 'deproteinizing' agent in the purification of influenza virus, suggested to us that this solvent might have many uses. In particular, we were concerned with 'deproteinizing' bacterial cells with the consequent release of polysaccharides. In view of the observation that this solvent is not miscible with water and that pneumococcal polysaccharide is soluble in water, the following experiment was performed.

D. pneumoniae, type I, smooth-phase cells were grown on beef heart infusion agar, harvested in 18 hr., washed several times and the concentration optically adjusted to 10^8 cells per millilitre of buffered saline, *p*H 7·2.

One part of cells to three parts of solvent were agitated for ten minutes in the high-speed homogenizer at maximum speed, removed and then centrifuged at 1,500 r.p.m. for 10 min. Three layers resulted: (1) an upper aqueous layer, (2) a middle gel-like layer, and (3) a bottom layer of solvent. The upper water layer was removed and treated as above for three more successive solvent extractions. During such treatment further gel-like material was removed.

The final water layer was tested for immunological activity by use of the interfacial-precipitin test using antiserum prepared against whole smooth cells. A positive reaction resulted immediately upon contact.

After concentration by evaporation in a dialysis casing with a fan, it was determined that the material extracted was strongly Molisch-positive, ninhydrin-negative and upon paper electrophoresis showed no indications of containing protein. Moreover, ultra-violet absorption tests did not indicate any absorption

at 2600 A., thus ruling out the possibility that water-soluble nucleoproteins might be present.

That the extract was not the *C* somatic polysaccharide was ruled out in two ways. With alcohol precipitation we recovered all the material in the water layer by the addition of 1·5 volumes of 95 per cent ethanol, and secondly, we did not obtain a positive precipitin reaction when rabbit anti-*C* anti-serum was employed.

Few data are available on the chemical and physical properties of this particular polysaccharide, and we examined only those properties which had been reported. The $[\alpha]_D$ of our material was +260° as compared to a reported[3] range of +253 to +278°. Acid hydrolysis followed by chromatography indicated galacturonic acid and an unidentified amino-containing material. Nitrogen values of 4·82 per cent were also obtained.

In view of the correlative findings obtained it is felt that a rapid and apparently specific method for the isolation of the pneumococcal polysaccharide has been obtained. With the present interest in bacterial polysaccharides (lipo-polysaccharide endotoxin studies) such a procedure might very well serve to obtain large amounts of microbial polysaccharides more rapidly and possibly more specifically than existing methods. One of us (A. S. M.) has also utilized this method for tissue polysaccharides and finds it just as specific. Experiments under way are designed to test the applicability of this method to a wide variety of microbial polysaccharides.

A. S. Markowitz
Jack R. Henderson

Department of Bacteriology,
University of Illinois
College of Medicine,
Chicago 12, Illinois.

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A New Synthesis of Histidyl Peptides

Although many peptide groups containing L-histidine have been found in the biologically active substances, for example, insulin, ribonuclease, adrenocorticotropic hormones, etc., no satisfactory method for the synthesis of the histidyl peptide has been so far reported. As a starting material, N(α)-carbobenzoxy-L-histidine is not suitable except for the azide route[1], because it is scarcely soluble in the usual organic solvents. We have devised a simple synthetic method for the preparation of the histidyl peptide from dicarbobenzoxy histidine.

N(Im),N(α)-dicarbobenzoxy-L-histidine was prepared in 81 per cent yield from L-histidine monohydrochloride monohydrate and carbobenzoxychloride by the usual Schotten–Baumann method. In this procedure sodium carbonate was used as the condensation reagent instead of sodium hydroxide. The dicarbobenzoxyhistidine produced, which was readily soluble in organic solvents, was available for the synthesis of the histidyl peptide.

5 gm. of L-histidine monohydrochloride monohydrate was dissolved in 48 ml. of 1 *N* sodium hydroxide solution and, after addition of 5·3 gm. of sodium carbonate, 8·1 gm. of carbobenzoxychloride was added gradually to the solution with vigorous stirring at 0° C. for 1–1½ hr. As the reaction proceeded, the product was precipitated. The reaction mixture was allowed to stand at room temperature for ½–1 hr. with stirring. Then it was brought to *p*H 3·0 with 6 *N* hydrochloric acid. The gelatinous mass produced was separated from the supernatant by decantation and was triturated with 15–30 ml. of 99 per cent ethanol. The white crystals were collected and washed with 99 per cent ethanol. The yield was about 8·6 gm. (81 per cent). Recrystallization from acetone–water gave white needles of N(Im),N(α)-dicarbobenzoxy-L-histidine (melting point 103–105° C. (dec.); $[\alpha]_D^{14} = +34{\cdot}01$ (*c*, 28·99 mgm./ml. ethyl acetate); calc. for $C_{22}H_{21}O_6N_3.H_2O$, C, 59·86, H, 5·25, N, 9·52 per cent; found, C, 59·64, H, 5·11, N, 9·46 per cent; water of crystallization: calc., 4·08 per cent, found, 4·19 per cent).

The product is easily soluble in ethyl acetate, acetone, benzene, dioxane, tetrahydrofurane and chloroform, moderately soluble in ether, warm methyl alcohol and warm ethyl alcohol, and insoluble in water and petroleum ether. It is unstable in both alkaline and hot acidic solutions.

The carbobenzoxy groups were removed with hydrogen-bromide glacial acetic acid or with concentrated hydrochloric acid at 37° C., and the resultant product was found to be identical with the authentic L-histidine.

Some dicarbobenzoxypeptide derivatives were synthesized by Sheehan's method[2]. Derivatives of L-histidyl-O-benzyl-L-serine methyl ester, L-histidyl-L-leucine methyl ester, L-histidyl-L-threonine methyl ester, L-histidyl-L-glutamic acid diethyl ester and L-histidyl-L-methionine methyl ester were prepared from dicarbobenzoxy-L-histidine monohydrate and the corresponding amino-acid esters using dioxane or chloroform as a solvent in 81, 68, 79, 70 and 85 per cent yield, respectively. Melting points, specific rotatory power and analytical data of some dicarbobenzoxyhistidyl peptide esters are shown in Table 1.

It was shown in the preliminary experiment that dicarbobenzoxy-L-histidyl-L-leucine methyl ester underwent both saponification of ester and removal of the carbobenzoxy groups simultaneously by the treatment with concentrated hydrochloric acid at 37° C. for 50 min. and was converted to L-histidyl-L-

Table 1. Dicarbobenzoxy-L-Histidyl-L-Amino-Acid Esters

Peptide derivatives	Yield (per cent)[a]	Melting point (° C.)	Optical rotation	Analysis					
				Found			Calculated		
				C	H	N	C	H	N
Di-cbzo[*]-L-His-L-LeuOMe	68	101–3	+ 21·44[b]	63·14	6·31	10·44	63·26	6·22	10·18
Di-cbzo-L-His-O-Bz[†]-L-SerOMe	81	113–5	+ 19·80[c]	64·75	5·57	9·54	64·48	5·58	9·12
Di-cbzo-L-His-L-Glu(OEt)$_2$	70	78–80	+ 0·21[d]	60·42	5·92	9·06	61·17	5·96	9·19
Di-cbzo-L-His-L-ThrOMe	79	148–50	+ 12·74[e]	59·61	5·77	10·21	60·21	5·61	10·40
Di-cbzo-L-His-L-MetOMe	85	110–13	+ 9·07[f]	59·10	5·55	9·72	59·14	5·67	9·85

(*a*) Referred to the crystals primary obtained; (*b*) *c*. 29·0 mgm./ml. ethyl acetate; (*c*) *c*. 29·6 mgm./ml. ethyl acetate; (*d*) *c*. 28·5 mgm./ml. ethyl acetate; (*e*) *c*. 30·5 mgm./ml. glacial acetic acid; (*f*) *c*. 28·0 mgm./ml. glacial acetic acid, exceptionally at 22° C.
[*] cbzo, carbobenzoxy. [†] Bz, benzyl.

leucine (melting point 212–14° C. (dec.). Calc. for $C_{12}H_{20}O_5N_4$, N, 20·88 per cent; found N, 20·54 per cent).

SHIRO AKABORI
KENJI OKAWA
FUMIO SAKIYAMA

Department of Biochemistry,
Faculty of Science,
Osaka University, Osaka.

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Electrophoretic Behaviour of *i*-Urobilin and Stercobilin

As the urobilinoid pigments *i*-urobilin and stercobilin are known to contain both basic and acidic groups, we have investigated their electrophoretic behaviour—yet unstudied—at various *p*H values. Paper electrophoresis was performed at 120 V., in acetate buffer (a mixture of *M*/5 acetic acid–sodium acetate buffer and 0·9 per cent sodium chloride solution) in the *p*H range less than 6·0, and barbital buffer (Michaelis sodium barbital–sodium acetate–hydrochloric acid buffer) at *p*H greater than 6·0; the positions of the coloured spots were observed directly during the procedure, but even minute quantities of urobilinoid pigments could be seen at the end of the run after spraying the papers with Schlesinger reagent (saturated zinc acetate solution in ethanol), and observing the green fluorescence in ultra-violet light. With the exception of the sharply defined *p*H value of 4·41 at which both urobilinoid pigments became immobile in the electric field, they moved towards the cathode at *p*H less than 4·41 and toward the anode at *p*H greater than this value, the direction of movement, which was the same for both pigments, being dependent only on the *p*H. However, the rate of movement of these materials differed at various *p*H levels: thus in buffers around *p*H 5·0 and at *p*H less than 4·41 stercobilin migrated faster toward the anode or cathode, respectively, whereas at higher *p*H values (8·6) urobilin was found to move faster than stercobilin in the anode direction.

As these substances are known to be ionized even at their isoelectric point[1], the basic and acid groups were found to be in equilibrium in the electric field around *p*H 4·41, but below this isoelectric point the direction of migration is determined by the ionized basic groups, and above this *p*H value by the ionized acid groups.

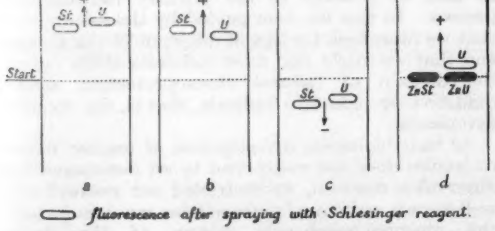

Fig. 1. Diagrams of electrophoresis paper strips. *St*, stercobilin; *U*, *i*-urobilin; arrow indicates migration in anodic or cathodic direction. Environment: (*a*) barbital buffer solution, *p*H 8·6; 7-hr. run; (*b*) acetate buffer, *p*H 5·5; 8-hr. run; (*c*) acetate buffer, *p*H 3·8; 4-hr. run; (*d*) electrophoretic behaviour of zinc complexes of urobilinoid pigments in barbital buffer, *p*H 8·6; 1-hr. run. Part of urobilin left the starting line

As the *pK* of stercobilin is known from spectrophotometric determinations[2] to be 8·0, at *p*H 8·0 only half the molecules of this substance are dissociated, whereas at the same *p*H *i*-urobilin characterized by *pK* 7·0 is far more completely dissociated, hence the greater mobility of the latter at *p*H 8·0, above its *pK*. This more acid character of *i*-urobilin and more basic property of stercobilin may be explained on the basis of the lactam structure of urobilinoid pigments proposed by Birch[3] and verified by Gray and Nicholson[4]. The NH-groups of the end rings attached to a conjugated system of double bonds in urobilin impart a greater acidity than the NH-groups in stercobilin behaving as ordinary amides. The nitrogen atom of an ordinary amide may more readily be protonated than the nitrogen atom of the end rings of urobilin; hence the faster migration of urobilin at high *p*H and of stercobilin at low *p*H.

However, the electrophoretic separation of stercobilin and *i*-urobilin is not yet sufficient for the practical isolation of either material from the other, but they may be isolated, with the aid of their electrophoretic behaviour, from mixtures containing the bile pigments.

The zinc complexes of the urobilinoid pigments were immobile during the electrophoretic procedure and could be detected at the 'start' position without spraying. However, their stability was limited, part of the pigments successively leaving the starting point and behaving as urobilinoids containing no zinc. The stability of zinc stercobilin proved more resistant to the action of the electric field than zinc *i*-urobilin.

I wish to thank Prof. C. J. Watson for sending samples of pure materials, as well as Dr. J. Toth for his valuable advice.

I. L. KAHÁN

Department of Medicine,
University Medical School,
Szeged, Hungary.
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A Possible Basis for the Anti-inflammatory Activity of Salicylates and other Non-Hormonal Anti-Rheumatic Drugs

RECENT studies have shown that sodium salicylate and acetyl-salicylic acid increase oxygen consumption in rats, rabbits and man[1–3]. Sproull has shown that both sodium salicylate and 2 : 4-dinitrophenol stimulate metabolism in mouse-liver slices[4], but has recently found a difference between the slopes of the concentration–response curves for the two compounds[5]. Reid has also directed attention to these similarities, and has shown that both compounds inhibit the growth of wheat coleoptiles[6]. Cochran[3] suggested that the stimulation of respiration by salicylate may be of fundamental importance in the therapeutic action of the drug.

2 : 4-Dinitrophenol is known to uncouple oxidative phosphorylation in mitochondrial preparations[7], and Brody[8] and Penniall *et al.*[9] demonstrated that sodium salicylate and acetylsalicylic acid also uncouple in very low concentrations. Smith and Jeffrey[10] pointed out that most of the previously observed effects of

salicylates on carbohydrate metabolism could be explained satisfactorily in terms of the uncoupling of oxidative phosphorylation.

The possibility occurred to us that the anti-inflammatory activity of non-hormonal anti-rheumatic drugs might be related to their capacity to uncouple oxidative phosphorylation. These ideas have recently been strengthened by the preliminary findings of M. J. H. Smith (private communication) that phenylbutazone in a concentration of 7·5 mgm./100 ml. completely inhibits the uptake of inorganic phosphate accompanying the oxidation of β-hydroxybutyrate by mitochondria prepared from rat-liver. At a concentration of 4 mgm./100 ml., phenylbutazone uncoupled oxidative phosphorylation to the extent of about 80 per cent.

The anti-inflammatory effects of a number of compounds have therefore been examined and compared with their reported ability to increase oxygen-consumption *in vivo*, or to uncouple oxidative phosphorylation *in vitro*.

For the measurement of anti-inflammatory activity we used a modification of the ultra-violet erythema test first described by Wilhelmi[11]. In this, a small area of the depilated back of a guinea pig was exposed for 20 sec. to the ultra-violet radiation from a Hanovia 'Kromayer' lamp. Animals received test-substances or saline by mouth 30 min. before irradiation, and 120 min. later the degree of erythema was estimated visually, and given a score 0–4. By using graded doses it was possible to obtain an approximate *ED*50 for those compounds which inhibited the erythema. Sodium salicylate, aspirin and phenylbutazone were all active in doses which were approximately related to their clinical anti-rheumatic doses.

The results obtained in this test, together with such data as are available on the effects of the compounds on oxidative phosphorylation *in vitro* and on oxygen consumption *in vivo*, are given in Table 1. The results for the effects of the compounds on oxygen consumption were obtained by Meade in rats[1], except for the information on 2 : 4-dinitrophenol, which was obtained by Reid[2] in rabbits. The data relating to the uncoupling of oxidative phosphorylation were obtained from Brody[8], except that for phenylbutazone[11] and 2 : 4-dinitrophenol[5].

Table 1. A Comparison of the Effects of a Number of Compounds on the Inhibition of Ultra-violet Erythema in Guinea Pigs, with Oxygen Consumption in Rats or Rabbits, and with the Uncoupling of Oxidative Phosphorylation *in vitro*

Compound	Erythema inhibition. Approximate oral *ED*50 (mgm./kgm.)	Increased oxygen consumption *in vivo*	Uncoupling of oxidative phosphorylation
Benzoic acid	—	—	—
Salicylic acid	120	+	+
Acetylsalicylic acid	80		+
Methyl salicylate	320		+
m-Hydroxybenzoic acid	—	—	
p-Hydroxybenzoic acid	—	—	
2 : 3-Dihydroxybenzoic acid	—	—	+
2 : 3-Diacetoxybenzoic acid	—		
2 : 5-Dihydroxybenzoic acid (gentisic acid)	—	—	—
2 : 6-Dihydroxybenzoic acid (γ-resorcylic acid)	—	—	—
Salicylamide	—		—
4-Aminosalicylic acid	—		—
Phenylbutazone	12·5		+
Phenazone (antipyrine)	320		—
2 : 4-Dinitrophenol	—	+	+

+, Active; —, Inactive; blank, not known.

It will be seen that there is a general parallelism between erythema inhibition, the increase in oxygen-consumption and uncoupling activity. The fact that the three most active non-hormonal anti-inflammatory compounds, experimentally and clinically, have been shown to uncouple, points to the possibility of a connexion between therapeutic activity and uncoupling.

Exact parallelism of the various properties is not to be expected since considerations of tissue distribution are likely to play a greater part in the *in vivo* tests than in the *in vitro* methods. Nevertheless, there are several inconsistencies. 2 : 3-Dihydroxybenzoic acid is inactive in our test and does not increase oxygen-consumption, though its capacity to uncouple was demonstrated by Brody who, however, found it to be less active than sodium salicylate. On the other hand, phenazone, which was slightly active in the erythema test, did not uncouple. The outstanding discrepancy, however, is the failure of 2 : 4-dinitrophenol to affect the erythema test. The explanation of this may lie in a difference between 2 : 4-dinitrophenol and salicylates in the site of uncoupling.

It is interesting, in view of the stress now being placed on the similarity of action of salicylates and 2 : 4-dinitrophenol, to note this different behaviour in a test which apparently bears some relationship to therapeutic efficiency.

S. S. Adams
R. Cobb

Research Department,
Medical Department,
Boots Pure Drug Co., Ltd.,
Nottingham.
Dec. 10.

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Direct Registration of an Instantaneous X-Ray Effect in Rats and Man

In order to study chemoprotection against radiation damage we tried to find radiobiological reactions as near as possible to the primary radiochemical process. In this we were guided by the assumptions that we must look for this in macromolecular systems and that we might find most radiosensitivity outside the domain of natural chemoprotection against oxidative or reductive radicals, that is, the respiring cytoplasm.

As radiobiological investigation of nuclear macromolecules does not easily lead to an instantaneously observable reaction, we restricted our research to a well-known system of extracellular macromolecules: the mucopolysaccharide matrix of the dermis connective tissue fibrils. The simplest way to study X-ray influence on the properties of the native matrix mucopolysaccharides is by collecting synovia and measuring its viscosity[1].

It was found that a moderate X-ray dose (500 r.) will at once decrease synovial viscosity by about

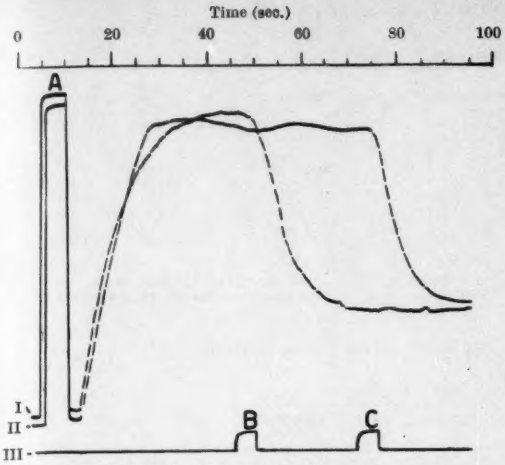

Fig. 1. Effect of X-irradiation on the intradermal injection pressure in the rat. I, II, pressure recordings of double injection apparatus. Injection with 0·9 per cent sodium chloride; III, irradiation signal; *A*, calibration (~ 100 mm. mercury); *B*, irradiation of I; *C*, irradiation of II. Dose-rate, 100 r./sec., 20 kV.

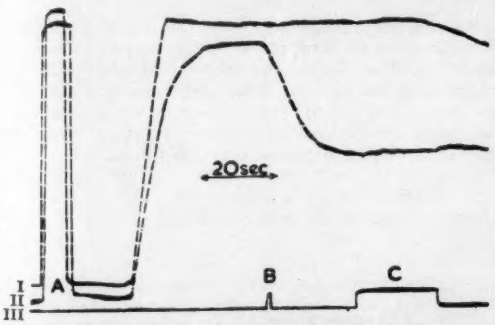

Fig. 2. Chemical protection by cystamine against the X-ray-induced pressure drop. I, II, pressure recordings of double injection apparatus. I, injection of 0·9 per cent sodium chloride with 0·01 per cent cystamine; II, injection of 0·9 per cent sodium chloride; *A*, calibration (~ 100 mm. mercury); *B*, irradiation of II; *C*, irradiation of I. Dose-rate, 100 r./sec., 20 kV.

20 per cent. It was also possible, by using an Epprecht Viscoprintmeter, to register a considerable drop in viscosity in 10 min. during irradiation with 200 r. per min. The radiation depolymerizing process is not complete, as addition of hyaluronidase to the irradiated product will cause a much greater depolymerization.

We then applied similar or smaller X-ray doses to the mucopolysaccharide matrix in the rat's abdominal muscle fascia, the cock's comb and finally to rat and human dermis. We measured the effects by Day's permeability method[2] for the fascia, and registration of slow injection pressure for the others. The details will be described elsewhere[3].

Some results are given in Figs. 1 and 2. 1 ml. of saline was injected slowly, intradermally, at constant velocity, and the pressure set up by the matrix resistance to fluid motion was measured electronically. This pressure reached a constant level of about 100 mm. of mercury in 5–10 sec., and fell rapidly on irradiation at 100 r. per sec.

Fig. 1 is a photokymograph pressure record from a double injection apparatus, the needle tips being irradiated at *B* and *C*, in the nembutalized rat. Fig. 2 is a similar record, needle I injecting saline with 0·01 per cent cystamine and needle II serving as a control. Fig. 3 is a micrograph record of the slow injection of saline into the human volar forearm dermis. A distinct decrease of matrix resistance is seen with 200 r.

With a fine needle (No. 20) inserted well into the dermis connective tissue these phenomena are easily reproducible and well suited for the investigation of local chemoprotection. The results may be valuable for a more general chemoprotection.

R. Brinkman
H. B. Lamberts

Physiological Institute,
University of Groningen.
Dec. 20.

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Changes in the Topographical Distribution of Glycogen in the Brain during Animal Hypnosis

Animal hypnosis is a general biological reaction of an inhibitory type, which is analogous to several syndromes of human psychopathological behaviour[1]. Its phenomenology is widely known, but its mechanism and metabolic basis remain unsolved[2].

A study of some of the problems of the mechanism of animal hypnosis has shown that at the onset an important part is played by certain functional units of the brain stem[3,4]. It is therefore possible to assume that the characteristic electrical manifestations of the brain-stem function are also related, in the course of this reaction, with metabolic processes which differ from the metabolism of other parts of the brain. As an indicator of changes in metabolic processes of different parts of the brain glycogen was chosen, because it is known that different functional states of the brain and different symptoms of behaviour are accompanied by changes in its concentration[5,6].

Animal hypnosis was evoked by a 180° rotation of rats about the vertebral axis in an apparatus which

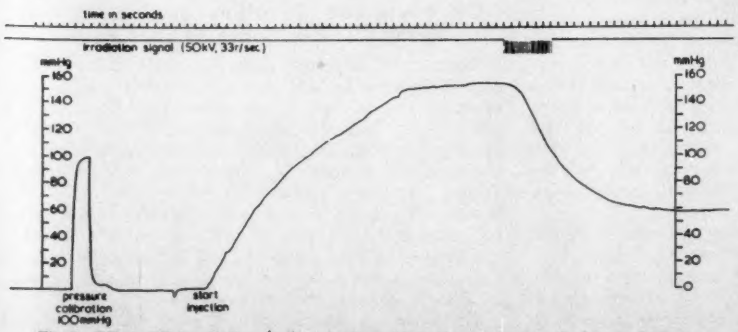

Fig. 3. Effect of X-irradiation on the intradermal injection pressure in the human forearm

Table 1. Concentration of Glycogen in the Course of Animal Hypnosis

Duration of animal hypnosis (min.)	Glycogen (mgm./100 gm.)*									
	Cerebral cortex	n	Diencephalon	n	Mesencephalon	n	Cerebellum	n	Medulla oblongata	n
0·01	91·5 ± 7·2	12	126·8 ± 6·8	12	133·2 ± 8·4	12	94·1 ± 9·1	10	144·3 ± 8·3	11
0·05			151·3 ± 6·1	8	142·4 ± 6·2	8				
0·10			161·7 ± 7·5	8	156·8 ± 7·4	7				
1·00	92·9 ± 10·3	9	184·2 ± 11·3	9	171·1 ± 9·4	8	86·8 ± 11·8	8	159·9 ± 9·7	8
1·10			173·4 ± 8·7	6	172·0 ± 7·1	6			162·2 ± 6·4	6
1·20			176·1 ± 6·4	7	183·2 ± 8·3	7			168·1 ± 8·8	7
1·30			182·0 ± 8·2	8	179·6 ± 6·2	8			179·6 ± 7·5	8
3·00	96·0 ± 8·1	8	190·2 ± 7·9	8	183·7 ± 8·5	7	89·4 ± 9·7	8	191·9 ± 11·3	8
8·00	94·3 ± 6·4	9	183·8 ± 7·8	8	187·2 ± 11·7	8	91·0 ± 8·3	8	188·3 ± 10·2	9

Control animals (awake): cerebral cortex, 89·6 ± 7·8 ($n = 19$); diencephalon, 128·1 ± 8·3 ($n = 21$); mesencephalon, 133·9 ± 7·4 ($n = 21$); cerebellum, 88·7 ± 7·8 ($n = 22$); medulla oblongata, 142·7 ± 7·6 ($n = 22$). n = Number of animals and of glycogen determinations.
* Mean ± standard error.

Table 2. Concentration of Glycogen after Arousal from Animal Hypnosis

Time after arousal (min.)	Glycogen (mgm./100 gm.)									
	Cerebral cortex	n	Diencephalon	n	Mesencephalon	n	Cerebellum	n	Medulla oblongata	n
0·01	90·1 ± 5·1	8	165·3 ± 7·9	7	172·0 ± 9·7	8	87·8 ± 7·4	8	151·6 ± 8·7	8
0·10			152·2 ± 9·2	10	160·8 ± 8·9	10			142·9 ± 8·2	10
0·20			133·4 ± 7·6	7	151·2 ± 10·8	6			134·8 ± 10·9	7
1·00			134·7 ± 9·8	6	130·9 ± 6·6	6			139·5 ± 9·6	6

Key as in Table 1.

makes possible a standard method of rotation. It is possible to attain in this way in the rat a state of sleep in a supine position which lasts for several minutes. The criterion of sleep evoked in this way is the absence of Magnus's righting reflexes which make the correct geotropic orientation of the animal possible. Animals were killed by decapitation into liquid air at various time intervals during hypnosis, as well as after arousal, and the concentration of glycogen was determined in the brain cortex, the diencephalon, mesencephalon, cerebellum and medulla oblongata by Kerr's method[7] except that the reduction compounds were determined after Nelson[8].

It can be seen from Table 1 that soon after the onset of animal hypnosis there is a significant increase in the concentration of glycogen in the diencephalon (after 0·05 min. $P < 0·05$, after 0·10 min. and later $P < 0·01$). Almost simultaneously glycogen begins to rise in the mesencephalon (after 0·10 min. $P < 0·05$, after 1·00 min. and later $P < 0·01$), while in the medulla oblongata significant changes appear later (after 1·20 min. $P < 0·02$, after 1·30 min. $P < 0·01$). There were no significant changes in the concentration of glycogen found in the cerebral cortex and in the cerebellum during the whole course of animal hypnosis.

As is shown in Table 2, there is a sudden decrease of glycogen in the medulla oblongata during arousal from animal hypnosis (the value after 0·01 min. is statistically not significant compared to the control). After 0·10 min. a decrease to values not significant when compared with the controls also occurs in the diencephalon. The same appears in the mesencephalon 0·20 min. after arousal. In general, the sequence in which the glycogen concentration returns to normal in topographically different parts of the brain after arousal is exactly opposite to the sequence of its increase during animal hypnosis.

The topographical distribution of changes in the glycogen concentration of the brain indicates that during animal hypnosis there are changes of the polysaccharide metabolism in the diencephalon, mesencephalon and the medulla oblongata, that is, in the brain stem structures, which according to electrophysiological findings also participate in this reaction. Similar changes take place in the course of natural sleep[4,9]. This finding, together with quite different changes in the topographical distribution of glycogen in the brain during pharmacological depression[10], indicates that animal hypnosis and natural sleep are probably similar forms of cerebral inhibition.

D. Svorad

Institute of Physiology,
Czechoslovak Academy of Sciences,
Prague.
Dec. 2.

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Occurrence of Ornithine in Sulphur-deficient Flax and the Possible Place of Ornithine and Citrulline in the Arginine Metabolism of Some Higher Plants

Although arginine has been recognized as a constituent of higher plants for many years, both as a structural unit in the protein and as the free amino-acid, two other components of the 'ornithine cycle' of animals, citrulline and ornithine, were not considered to be normal constituents of these plants. Wada, in 1930, isolated citrulline from *Citrullus vulgaris* Schrad.; but it was not again reported in higher plants until 1952, when Virtanen and Miettinen[1] detected it in *Alnus incana* L. and *Alnus glutinosa* L. Citrulline is now known to occur as a free amino-acid in plants of a number of families.

Evidence of ornithine in higher plants remains fragmentary. It has been detected chromatographic-

ally in *Hevea brasiliensis*, Müll.-Arg.[2], *Atropa belladonna* L.[3], *A. glutinosa*[1] and *Asplenium nidus* L.[4].

I have proved the presence of free ornithine in sulphur-deficient flax (*Linum usitatissimum*) plants where it is associated with citrulline and a large accumulation of arginine. The plants were grown and the amino-acid content examined as previously described[5]. Free ornithine was first detected in the plant extracts by the position of the ninhydrin-positive spot on two-dimensional chromatograms and by its reaction with vanillin[6]. Isolation of a larger quantity of ornithine was then attempted. A preliminary separation of the basic amino-acids in the plant extract was effected by using displacement chromatography[7] on 'Amberlite *IR* 120' and '*IR* 410'. This procedure also allowed a separation of arginine, which was a major constituent, from the other basic substances. One-dimensional paper chromatography was used to follow the progress of the isolation. The basic mixture at this stage contained citrulline, ornithine, traces of lysine and two unidentified ninhydrin-positive substances. Dinitrophenylation of these substances was effected by shaking an alkaline aqueous solution with a slight excess of 1,2,4-fluorodinitrobenzene for 2 hr. at 40° C. Excess fluorodinitrobenzene was extracted with ether and the solution acidified to *p*H 2. 2,4-Dinitrophenyl ornithine was separated from the mixture by extraction with 5 per cent butanol in benzene (v/v). The 2,4-dinitrophenyl ornithine was finally purified by repeated crystallization from methanol. Comparison of the X-ray powder photographs of this and the 2,4-dinitrophenyl derivative of pure ornithine confirmed chromatographic evidence that ornithine was a constituent of the plant material. (Thanks are due to the Mining and Metallurgy Department of the University of Queensland for taking these photographs.)

The presence of ornithine in association with citrulline and arginine in sulphur-starved flax and the roots of *A. glutinosa*[1] suggests that the classical ornithine cycle, which is known to operate in the mould, *Neurospora crassa*[7], may be a factor in the nitrogen metabolism of higher plants. However, with few exceptions, it has not been possible to demonstrate the presence of the enzyme arginase in higher plants, and it would appear that the production of urea from arginine is not an important metabolic process in such plants. Nevertheless the association of ornithine with citrulline and arginine in flax and *A. glutinosa* is of interest, particularly when it is coupled with the observations of Coleman and Hegarty[8], who have shown that DL-ornithine-2-^{14}C is readily metabolized by white clover and barley, citrulline and arginine being formed in appreciable quantity. They concluded from their experiments that enzymes effecting the conversion were operative in white clover and barley, though their presence was not confirmed by isolation.

It is suggested that in sulphur-starved flax the accumulation of ornithine and citrulline occurs as a result of a disruption in arginine metabolism. In a number of micro-organisms, some of which lack arginase, arginine is synthesized from ornithine via citrulline[9]. The reaction sequence ornithine, citrulline, arginine in these organisms is then not restricted to urea formation, but represents a general pathway for providing the arginine of cellular protein.

R. G. COLEMAN

Plant and Soils Laboratory,
Division of Plant Industry,
Commonwealth Scientific and
Industrial Research Organization,
Brisbane. Dec. 11.

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Influence of DDT and Lindane on Chordotonal Organs in the Cockroach

THERE has been much interest recently in stretch and strain receptors in Arthropods. Wiersma *et al.*[1] studied the responses of paired 'muscle receptor organs' in decapod Crustacea; these consist of

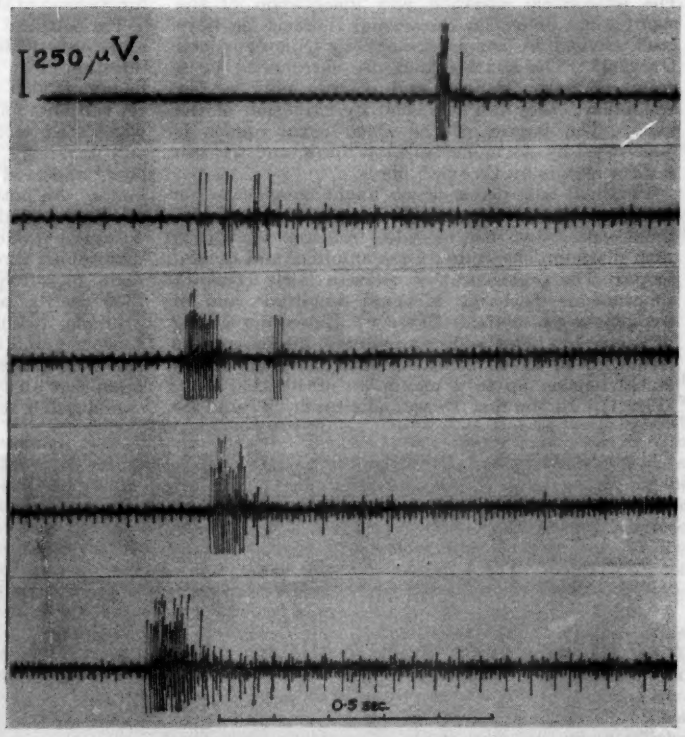

Fig. 1. Normal response of chordotonal organs in the coxa. Stepwise increase of mechanical tension produces an increasing frequency of small-amplitude impulses; the movement itself produces a burst of large spikes

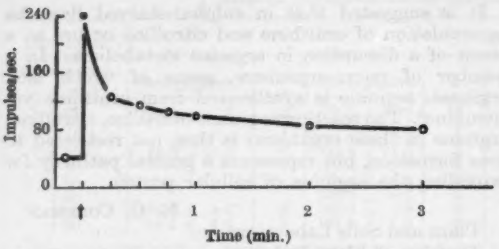

Fig. 2. Adaptation of a tonic receptor to constant tension. Tension applied at the arrow. Spontaneous activity 40 sec.$^{-1}$

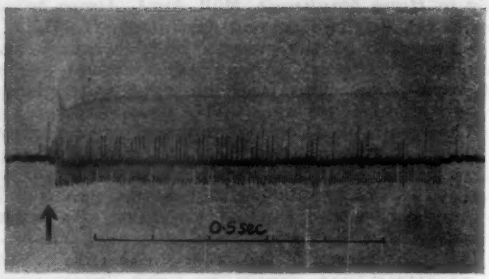

Fig. 3. A high-frequency train of impulses 1 hr. after the administration of 40 μgm. DDT. Movement indicated by the arrow

muscle fibres with intercalated tendinous regions and are located dorsally in the abdomen and thorax. They found a slowly adapting unit response (tonic) and a comparatively fast adapting unit (phasic). According to Finlayson and Lowenstein[2], proprioceptors in the dorsal longitudinal muscles of the abdomen of some saturniid moths consist of modified muscle fibres, and show tonic but not phasic discharges. In *Limulus*, Pringle[3] recorded tonic discharges from proprioceptive nerve endings in the cuticle of the femoro–tibial joint, and obtained phasic responses from more internally situated chordotonal-like organs. Much histological information is available about internal stretch receptors in insects[4], but apart from Hughes's[5] work on abdominal chordotonal organs, their physiological properties are unknown.

The following observations on a stretch receptor in the coxo-trochanteral joint of the leg of the cockroach *Periplaneta americana* L. may be of interest. The anatomical situation and innervation of the chordotonal organs in the second thoracic leg have been studied in our laboratory by Nijenhuis and Dresden[6]. The coxal organs are surrounded by a group of flexor muscles and contain only a few scolopidia; they are stretched by extension of the joint. The largest of the three coxal organs is innervated by six moderate-sized fibres, and the two smaller organs by six small fibres.

Proximal hair plates which might complicate the results were removed, and the activity of the chordotonal organs was then recorded from the nerve (3*B*) with platinum electrodes, a pre-amplifier and oscilloscope. The organs at rest show a fairly constant spontaneous discharge of small amplitude and of frequencies up to about 50 sec.$^{-1}$. Extending the leg in steps produces a low-amplitude discharge, the frequency of which increases with increasing mechanical tension up to a maximum of 100–250 sec.$^{-1}$ (Fig. 1). In the first 15 sec. adaptation is rapid (to 30–50 per cent of the initial discharge frequency), and then becomes slower (Fig. 2); after 10 min. the frequency is still about 1·5 times that of the spontaneous activity in the normal resting position of the leg. The movement itself is accompanied by a considerable discharge, the frequency of these impulses depending on the speed of movement and reaching a maximum of about 250 sec.$^{-1}$. During flexion this activity is completely absent. The amplitude of the slowly-adapting (tonic) discharges seldom exceeds 250 μV.; that of the phasic impulses is generally greater than 500 μV. This difference may be correlated with the presence of smaller and larger chordotonal organs and their corresponding axons. We have been unable to discover the reflex function of these discharges, possibly because of the difficulty of realizing adequate experimental conditions for the functioning of the central nervous system.

Toxicological observations have been made with some insecticides, the insects being poisoned by the injection of an emulsion. A high dosage of 30 μgm. lindane (*LD*50 = about 5 μgm.) produces a period of convulsions, followed within one hour by a stage in which the insect becomes almost completely paralysed and seemingly inexcitable. The sense organs, however, appeared to be unaffected, even after three hours. An entirely different result is obtained with DDT. A high dosage of 40 μgm. DDT (*LD*50 = about 25 μgm.) produced marked convulsions which were maintained throughout the experiment. In the first hour high-frequency 'trains' of action potentials (350 sec.$^{-1}$), as described by many authors (for example, Roeder[7]), could be observed both spontaneously and after mechanical stimulation (Fig. 3); the wide range of amplitudes (not illustrated) suggests that all types of fibre are excited. Later there was another remarkable feature of DDT poisoning;

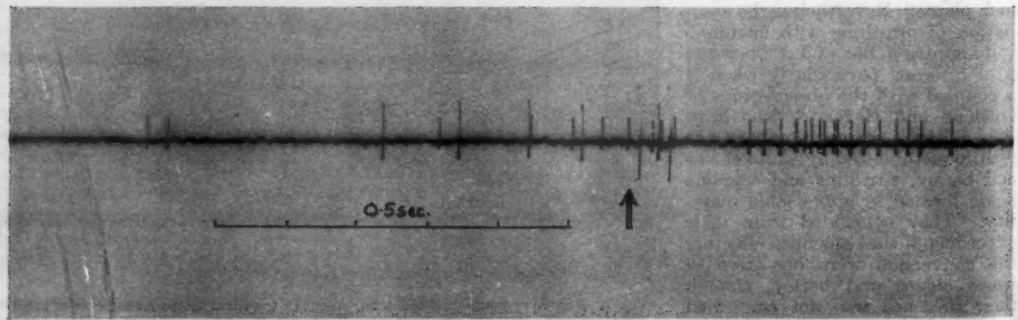

Fig. 4. The same preparation as in Fig. 3, but after 2·5 hr. Movement indicated by the arrow

the continuity and regularity of the tonic discharges was lost and only short trains at low frequency (5–10 sec.$^{-1}$) remained. At this stage the phasic response is reduced to a few impulses (Fig. 4), and the range of amplitudes becomes reduced, showing that there are fewer active fibres.

The preparations usually survived for many hours. The simplicity of the experimental procedure and the regularity of the responses make this preparation a very convenient one for physiological and toxicological investigations.

G. Becht

Laboratory for Research on Insecticides,
Vondellaan 6,
Utrecht.

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Direct Determination of the Active Phase of End-Plate Potential

It is well known that the duration of transmitter action in neuromuscular transmission is very brief, of the order of 4 msec., and prolonged decline of the end-plate potential is due to the slow dissipation of charge along and across the resting membrane[1–4]. The time course of the active phase of the neuromuscular transmission has been calculated by some authors[1,3], but it has not yet been obtained experimentally. In the present investigation the time course of the active phase of the transmitter producing the end-plate potential was recorded by a refined voltage clamp method (the original method was described by Hodgkin *et al.*[5]).

Two microelectrodes filled with 3 *M* potassium chloride were inserted into the end-plate focus of the curarized frog sartorius muscle. One of these electrodes recorded the membrane potential, and the feed-back amplifier regulated the current entering the other electrode in such a way as to hold the membrane potential at the resting value during the neuromuscular transmission. The membrane potential and the current which flowed through the current electrode were recorded with a double-channel oscilloscope. The focus of the end-plate was carefully located with multiple re-insertion of the electrode, and the current electrode was inserted within 50μ of the recording electrode. In order to increase the feed-back factor and also to reduce the capacitative escape of the feed-back current, a low-resistance electrode of about 5–10 MΩ was used especially for the current electrode. Fig. 1*a* shows the end-plate potential without feed-back and Fig. 1*b* the membrane potential clamped at the resting potential with negative feed-back and the feed-back current entering the current electrode during the neuromuscular transmission. The time course of the feed-back current represents the time course of the active phase, without electrotonic dissipation of charge, which produces the end-plate potential.

The general time course of the current was very similar to that of the active phase obtained by calculation[1,2]. The duration of rising phase was about 0·5 msec., and the peak to half-decay time was 0·6–0·9 msec., the total duration being 3–4 msec., at 18° C. The time course was prolonged by lowering the temperature or eserinizing the preparation, as will be reported in a later communication.

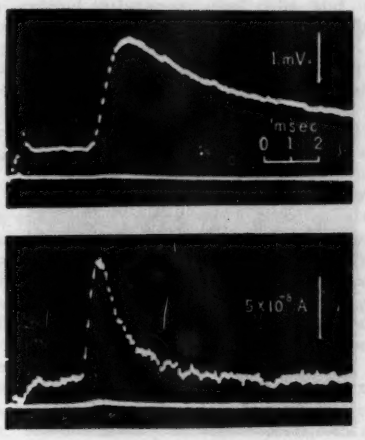

Fig. 1. *a*, End-plate potential recorded intracellularly from a curarized frog muscle; *b*, upper record—feed-back current flowing through the current electrode, so as to clamp the membrane potential at the resting value; lower record—the membrane potential held at the resting level with a voltage clamp method during the neuromuscular transmission. All records were recorded from the same end-plate using the double-channelled oscilloscope

Noriko Takeuchi
Akira Takeuchi

Department of Physiology,
Faculty of Medicine,
Juntendo University,
Tokyo.

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Abrasion of the Insect Cuticle by Aqueous Suspensions of Small Particles

I have recently had occasion to require a standard or repeatable degree of abrasion of the cuticle of an insect, the larva of *Rhodnius*[1]. It was observed that in regions where excreta containing crystals of uric acid had dried on the surface, the cuticle appeared to be more permeable, suggesting that the drying of suspensions containing solid particles might produce abrasion. This was tested by applying suitable suspensions in distilled water, allowing them to dry in air, removing the particles in a stream of water and then testing for abrasion by exposure to ammoniacal silver hydroxide[2].

Process white (barium sulphate), 'Almicide' (fine crystalline aluminium hydroxide), 'Carborundum' 500, and activated charcoal were used as test materials. In all cases there was extensive abrasion of the surface as revealed by silver staining (Fig. 1). This abrasion was most evident over the crests of the folds in the cuticle, although the particles were deposited also in the depressions. Abrasion was usually

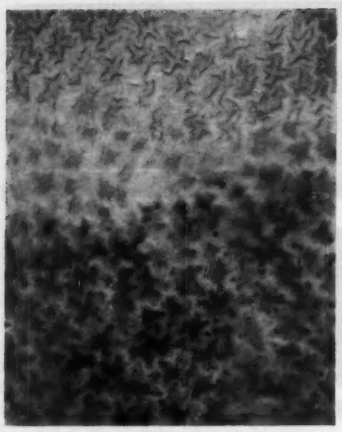

Fig. 1. Cuticle of fifth-stage larva of *Rhodnius*; intact insect immersed for 2 hr. in 5 per cent ammoniacal silver hydroxide. Upper half: normal, unstained. Lower half: area treated with alumina suspension; abrasion of crests of cuticular folds revealed by silver staining

most evident at the periphery of the dried deposit. The number of abraded points was naturally smallest with 'Carborundum' 500, where the particles are the largest. Abrasion does not occur if the powders are carefully applied to the surface in the dry state.

During the drying of these deposits the particles will be subjected to large surface tension forces. As the air replaces the water the particles or aggregates will be forcibly displaced first in one direction and then in another. The resulting abrasion would be expected to affect chiefly the crests of the cuticular folds and the margins of the deposit.

These observations have an obvious bearing on the entry of insecticides when crystals of poisons suspended in water are allowed to dry on the cuticle[2]; for abrasion of the surface facilitates the entry of insecticides[3]. They may also explain the increased loss of water from insects on which suspensions of activated charcoal have dried[4]. Indeed, it was suggested by Holdgate[5] that the increased transpiration observed by Glynn Jones[4] when suspended powders were allowed to dry on the cuticle might be due to abrasion brought about by surface forces.

V. B. Wigglesworth

Agricultural Research Council
Unit of Insect Physiology,
Department of Zoology,
University of Cambridge.

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Determination of Glucose and Lævulose in Body-Fluids

The current methods for the determination of monosaccharides in blood and other body-fluids are comparatively complicated and time-consuming. Moreover, they are more or less non-specific.

We have devised methods which are specially aimed at specific determination of blood glucose but which can also be used for a separate determination of lævulose. These methods employ condensation reactions between monosaccharides and certain aromatic amines to give coloured products in nearly water-free acid solutions[1]. The colours are characteristic and very suitable for colorimetry. Two new methods are described here: method *A*, using *p*-aminobenzoic acid as coupling reagent for the condensation; and method *B*, using *m*-aminophenol. These methods probably give principally different condensation products. *p*-Aminobenzoic acid reacts with aldosugars, such as glucose and galactose, and only to a small extent with ketosugars such as lævulose. *m*-Aminophenol reacts with both aldosugars and ketosugars.

(*a*) *Blood.* 0·1 ml. blood is pipetted into 1 ml. of a 5 per cent solution (method *A*) or 3 per cent solution (method *B*) of trichloracetic acid in water in a small centrifuge tube. The mixture is centrifuged.

Method *A*. 0·2 ml. of the clear supernatant is mixed in a 'Pyrex' test-tube with 4 ml. of a 5 per cent solution of *p*-aminobenzoic acid in glacial acetic acid. After heating for 15 min. in boiling water the tube is cooled and the absorbance measured against a reagent blank at 4700 A.

Method *B*. 0·1 ml. of the supernatant is mixed with 3 ml. of a 2 per cent solution of *m*-aminophenol in glacial acetic acid. After heating for 30 min. in boiling water the tube is cooled and the absorbance measured against a reagent blank at 5250 A.

(*b*) *Serum.* Precipitation of the proteins is not necessary for method *B*.

Method *B*. 0·01 ml. serum + 3 ml. *m*-aminophenol solution are treated as in *B* above.

(*c*) *Urine.* Method *A*. 0·002 ml. urine (or 0·1 ml. urine diluted 1/50) + 4 ml. *p*-aminobenzoic acid solution are treated as in *A* above.

Method *B*. 0·001 ml. urine (or 0·1 ml. urine diluted 1/100) + 3 ml. *m*-aminophenol solution are treated as in *B* above.

Ultramicropipettes, according to Sanz[2], can be used for the small quantities of urine. Each series of tubes should contain at least two standards of different concentration and one reagent blank.

Method *A* gives absorbances which are directly proportional to the sugar concentration between 50 and 1,200 mgm. glucose (or galactose) per 100 ml. blood or serum and between 0·1 and 6 per cent in urine. The colour is stable for at least three hours. The absorbance of lævulose is about 22 per cent that of glucose.

Method *B* gives absorbances which are proportional to the sugar concentration between 50 and 600 mgm. glucose (or galactose) per 100 ml. blood or serum and between 0·5 and 6 per cent in urine. The colour is stable for at least three hours. The absorbance with lævulose is about 138 per cent that of glucose.

The quality of some of the reagents is of utmost importance to the purity of the colour. The acetic acid must be free of both water and aldehydes, otherwise a false coloration of blank and samples is obtained. The blank must be practically colourless after boiling. The following brands of acetic acid have proved acceptable: 'Analar' p.a., 'Riedel de Haen' p.a., 'Skogen purum' (Skogens Kemiska AB, Kilafors, Sweden), but better results are obtained if the acid is redistilled. Acetic acid from some other manufacturers could not be used even after redistillation. The *p*-aminobenzoic acid causes no trouble: ours is from AB Ferrosan, Malmö, Sweden. It can be used directly, giving linear readings. The *m*-amino-

phenol at present available commercially is usually impure and has to be re-crystallized from toluene. *m*-Aminophenol, sufficiently pure for direct use, can be ordered from Ferrosan Co., Malmö, Sweden. The reagents must be made fresh every day.

The methods give different reactions with aldosugars and ketosugars, and consequently they can be used for quantitative differentiation between these two groups.

Added in proof. The wave-length at which *p*-aminobenzoic acid gives a linear standard curve and similar readings for the same concentration of glucose in blood and water varies with different brands of glacial acetic acid. As a routine method we definitely prefer method *B*.

JAN EK
ERIC HULTMAN

Clinical Laboratory,
St. Erik's Hospital,
Stockholm.
Nov. 27.

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Deposition of Glycogen and Changes in some Enzymes in Brain Wounds

IT is well established that areas of fresh brain injuries are surrounded by a concentric zone showing a marked deposition of glycogen[1-3]. In the healthy adult mammalian brain, however, glycogen is scarcely demonstrable by routine histological fixation and staining methods, except for the paraventricular structures[4,5]. In addition to possessing a large amount of rather stable glycogen, the paraventricular structures reveal an evident action of phosphatases[6,7] and relatively slight activity of respiratory enzymes[8,9].

Stab wounds were made in the cerebral cortices of adult rats and the cerebri examined from 6 hr. to 21 days after the operations. For staining glycogen, animals were subjected to rapid intravascular perfusion fixation and the sections were stained with the lead tetraacetate–Schiff method[4]. (This method brought out not only glycogen in the paraventricular structures and in the brain wounds but also labile glycogen present in other portions of the brain.) Fresh frozen sections were used for histochemical demonstration of acid and alkaline phosphatases, 5-nucleotidase, phosphorylase, succinic dehydrogenase and cytochrome oxidase[3].

The lead tetraacetate–Schiff method, applied to paraffin sections of the brain, stains the mucopolysaccharide of the ground substance as well as glycogen similarly to the periodic acid–Schiff method. The stab wounds were surrounded by two distinct zones in 6 hr.–3 days, the inner Schiff-negative or slightly positive zone, deprived of ground substance, and the outer Schiff-positive glycogen-containing zone[3,3] (Fig. 1). After 3 days the inner zone began to diminish in extent and disappeared in 10 days. The outer zone showed moderate glycogen deposition in the intercellular ground substance, glial cells and capillary walls in 6 hr. The zone revealed the maximal glycogen accumulation at 3 days and was followed by a gradual decrease, reaching normal conditions in 14 days. In accordance with the result for glycogen, the outer glycogen-containing zone exhibited a gradual increase in activity of both phosphorylase (Fig. 2) and alkaline phosphatase (Fig. 3) for a period of three days in the intercellular ground substance and capillary walls. Afterwards it was followed by a diminution of both enzyme reactions. The same area showed, however, a slight decrease of succinic dehydrogenase activity (Fig. 4) from 1 to 3 days and subsequent gradual recovery. The reduced reaction could be estimated from the decrease in diformazan granules of smaller size compared with those in the adjoining healthy brain tissues (Fig. 4). The inner layer, deprived of mucopolysaccharide, showed a general decrease in activity of most enzymes tested, excepting a slight increment of 5-nucleotidase and acid phosphatase. With recovery of the wounds, the activity of all enzymes tested in the inner layer was restored to normal conditions. From about 7 days onwards edges of the wounds began to adhere to each other. The adhered linear portion revealed marked amounts of mucopolysaccharide and small amounts of glycogen granules. There were also increases in activity of alkaline and acid phosphatases, 5-nucleotidase and phosphorylase and a reduction of respiratory enzymes.

From these results it is clear that the glycogen deposition in the walls of the brain wounds is accompanied by the concomitant increase in activity of phosphorylase and alkaline phosphatase, and by a slight decrease in succinic dehydrogenase activity. It is suggested by several investigators[10,11] that glycogen deposition may be correlated with a poor oxygen supply or a high anaerobic metabolism. Friede[12] expressed a similar opinion that an increment of glycogen in the brain may be an indication

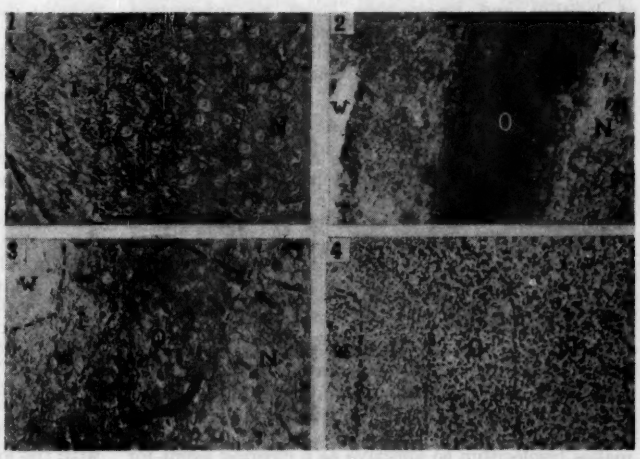

Fig. 1. The lead tetraacetate–Schiff method. Marked deposition of glycogen is observed in the outer layer, which occurs in the neuroglial cells, intercellular ground substance and capillary walls. The inner zone shows a decreased staining. × 125.
Fig. 2. Takeuchi–Kuriaki's method for phosphorylase using iodine reaction. Enzyme activity is shown in the outer zone. × 150. Fig. 3. Gomori–Takamatsu's phosphatase method. Marked activity of alkaline phosphatase is demonstrated in the capillary walls and intercellular substance especially of the outer layer. × 150.
Fig. 4. Seligman–Rutenburg's method for succinic dehydrogenase as modified by Rosa-Velardo. The inner layer reveals little, if any, activity, the outer layer somewhat weaker activity than the normal healthy brain tissue. × 150
All the sections were taken from brains three days after the stab wounds. *W*, wound; *I*, inner layer; *O*, outer layer *N*, normal healthy tissue

of lowered metabolic rate. Our histochemical observations lead us to suppose that glycogen accumulation, at least in brain wounds, may be correlated with the decreased oxidative metabolism and possibly with prevailing anaerobic glycolysis in the same localities. Apart from somewhat stable glycogen, either in the paraventricular structures or in brain wounds, adult mammalian brains contain variable amounts of labile glycogen, which are demonstrable only after intra-vital perfusion fixation. This labile glycogen co-exists with some respiratory enzymes[4,9]. The probable presence of at least two kinds of glycogen in the brain seems to be comparable with the results on the heart muscle and conducting system reported by Schiebler[10].

Nobuo Shimizu
Yoriaki Hamuro

Department of Anatomy,
Osaka University Medical School,
Osaka-shi, Japan.

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Clearing Action of Lysolecithin

Recent communications[1,2] indicate the growing interest in the properties of lysolecithin. Its clearing action on lecithin sols is remarkable, and mixed sols of lecithin and lysolecithin show an interesting viscosity maximum[3]. The lyso-compound has a considerable effect on the stability of lecithin sols in the presence of salts[3]. Neumann and Habermann point out[2] that the formation of lysolecithin *in vivo* could provide a mechanism for changes in cell membrane permeability.

In these laboratories, we are at present studying the physical properties of lysolecithin sols. Diffusion measurements indicate that the aqueous sols contain large micelles consisting of about 273 molecules of the monomer[4]. These large micelles can incorporate lecithin, and our diffusion measurements with mixed sols of the two phosphatides indicate that the mixed micelles are very much larger than those of pure lysolecithin.

The surface activity of lysolecithin is very high; 10^{-4} per cent wt./vol. in water gives a surface tension (Saunders, L., and Robinson, N., unpublished) of 66 dyne $cm.^{-1}$ at 20° C. It is this combination of high surface activity and large micelle size which makes lysolecithin so effective as a clearing agent for lipid sols.

By Hanahan's method[5], we have made batches of up to 15 gm. of lysolecithin, using Russell viper venom, for the gift of which we are indebted to Dr. A. C. White of the Wellcome Research Laboratories, Beckenham. However, we have found that the product does not give a clear solution in warm ethanol. Prolonged spinning of this warm solution in a high-speed centrifuge gave a residue of weight similar to the weight of venom used in the preparation. We therefore recommend that lysolecithin should be recrystallized several times from warm ethanol, clarifying the warm solution each time[3]. If this is not done, the product will contain traces of venom which will confuse the results of experiments in which the lysolecithin is brought into contact with lecithin sols.

The final product is a white solid, of crystalline appearance, which shows a parallel extinction under the polarizing microscope.

L. Saunders
I. L. Thomas
N. Robinson

School of Pharmacy,
University of London,
17 Bloomsbury Square,
London, W.C.1.

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Relative Distribution of the Mitochondria in the Two Types of Fibres in the Pectoralis Major Muscle of the Pigeon

It has been noted that the pectoralis major muscle of the pigeon consists of two types of fibres, one of them a white, broad and glycogen-loaded variety, and the other red, narrow and fat-loaded[1], and that the lipase activity is much greater in the latter than in the former[2]. Recent studies conducted in our laboratories[3,4] suggest the presence of a well-organized fatty acid oxidation system in the breast muscle of flying birds. Since the mitochondria are known to be the seat of oxidative processes, it was thought desirable to study the relative distribution of the mitochondria in the two types of fibres in the pectoralis major muscle of the pigeon.

For the demonstration of mitochondria, Altmann's method, as described by Gray[5], was adopted. On observing the sections under oil immersion, mitochondria were found to be mainly located in the narrow fibres and extremely sparse in the broad ones. Chappell and Perry[6] reported that mitochondria in the breast muscle of pigeon constitute about 20 per cent of the total nitrogen of the muscle. Our work shows that the broad fibres, which make up not less than one-fifth the volume of the muscle, are poor in mitochondria. Evidently the main bulk of mitochondria obtained by Chappell and Perry must have come from the narrow fibres.

Studies on the cyclophorase preparation of skeletal muscle by Paul and Sterling[7] show that there exists a correlation between granule count and oxidative activity. Chappell and Perry[6] correlated the low oxidative activity of the rabbit muscle suspension with the low granule content, and suggested that this tissue (rabbit muscle) must be largely anaerobic in function.

From all these observations it is evident that the pigeon breast muscle is made up of two distinct components the morphological characteristics of which seem to be correlated with function. With the poor mitochondrial content associated with the high glycogen-load, lack of myoglobin and smaller surface

area, the white broad fibres seem to be well equipped largely for functioning anaerobically. On the other hand, the high mitochondrial content, together with the large store of fat, greater lipase activity, the presence of myoglobin and greater surface area afforded in the narrow fibres, suggests that they have a well-organized oxidative system. Further work towards a clearer understanding of the potentialities of these two distinct types of fibre and their mitochondria is in progress.

One of us (R. M. N.) is indebted to the Government of India for the award of a Senior Research Scholarship, which made this work possible.

J. C. George
R. M. Naik

Laboratories of Histochemistry and Animal Physiology, Department of Zoology, M.S. University of Baroda, Baroda, India. Nov. 17.

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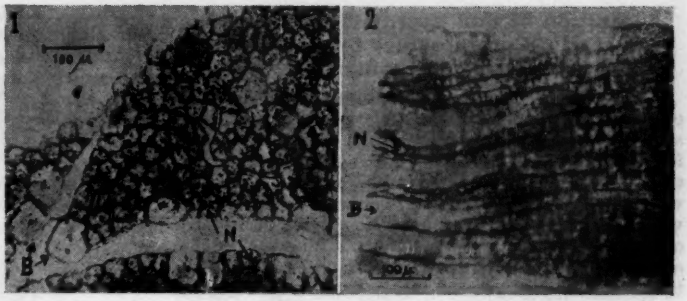
Histochemical Demonstration of Lipase Activity in the Pectoralis Major Muscle of the Pigeon

Our earlier observation that the pigeon breast muscle contains a lipase[1] has led to the present attempt to demonstrate its presence in this muscle using histochemical methods. The 'Tween' method of Gomori[2] was chosen for the purpose. The substrate used was 'Tween 80' (Atlas). The incubation medium contained 2 ml. 10 per cent calcium chloride, 2 ml. 5 per cent 'Tween 80', 5 ml. bicarbonate buffer[3] of *p*H 8·4, 40 ml. distilled water and a crystal of thymol as preservative. The mixture was kept overnight in an oven at 40° C. and the precipitate formed was filtered off before use. Sections were incubated for 10–12 hr. at 40° C., which is the optimum temperature for this lipase[1]. Parallel experiments were run with sections of pancreas of the same animal for comparison and confirmation of the results. It was noted that acetone destroyed the lipase, and experiments with paraffin sections of tissue fixed in acetone yielded negative results.

A very simple method of preparing sections was adopted and was found to be highly satisfactory. The tissue was cut out immediately after decapitating the animal and placed over ice in the deep freeze of a refrigerator; it was frozen hard in less than half an hour, and without removing it from the deep freeze it was trimmed to shape and thin sections cut with the aid of a cold, sharp razor blade and transferred to an albuminated slide by means of a cold needle. Very thin sections without any appreciable loss of the enzyme in them could thus be obtained. After drying at room temperature to ensure adhesion, the sections were fixed for 16 hr. in cold (4° C.) 6 per cent formalin neutralized with phosphate[4]. They were then washed in running water for about an hour, washed with distilled water and incubated in the above incubation medium. The rest of the procedure was the same as described by Pearse[4]. Since the fibres were stained brown after treatment with ammonium sulphide, the sections were differentiated by treatment with a few drops of hydrogen peroxide in a Coplin jar of 70 per cent alcohol for a few seconds. The sections were not counterstained. Sections which were boiled for 10 min. were used as controls.



Photomicrographs of (1) a transverse and (2) an oblique section of the pectoralis major muscle of the pigeon showing the disposition of lipase. *B*, broad fibres; *N*, narrow fibres

Fig. 1 shows the cross-section of a part of the pectoralis major muscle of the pigeon (*Columba livia*) in which the two types of fibres, a narrow and a broad variety, as described by George and Naik[5,6], are clearly discernible. The dark spots in the photograph represent the brownish black precipitate of lead sulphide. It can be seen that the precipitate is abundant in the fat-loaded narrow fibres, whereas the glycogen-loaded broad fibres contain very little. Control sections do not show any precipitate. It is therefore inferred that in the pigeon breast muscle the lipase occurs mostly in the narrow fibres. However, the occurrence of a few grains of the precipitate in the broad fibres is not convincing evidence that they are formed in the same fibres; study of a large number of sections indicates that these granules in the broad fibres are the result of diffusion of products of hydrolysis from the narrow fibres. Fig. 2, showing an oblique section of the muscle giving the longitudinal aspect of the two types of fibres, shows large areas of the broad fibres devoid of these precipitates. This supports the view that lipase is confined, by and large, to the narrow fibres, and very little, if any, occurs in the broad fibres. By contrast, in the pancreas, where lipase is known to be present in large amounts, the precipitate was found to be thickly dispersed throughout the section.

J. C. George
K. S. Scaria

Histochemical Laboratory, Department of Zoology, M.S. University of Baroda, Baroda, India. Sept. 9.

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Separation of Bull Spermatozoa carrying X- and Y-Chromosomes by Counter-Streaming Centrifugation

Experiments[1] in which a small fraction (1/20–1/15) of the most easily sedimenting spermatozoa, separated by counter-streaming centrifugation, were used for inseminations gave the unexpected result that the 11 calves obtained from 23 first inseminations were all males. Recent experiments on a larger scale with the same technique have now been performed on semen from 10 different bulls. Whereas in the earlier experiments 1,100 r.p.m. was used, the separation in seven of the present experiments was performed at the same velocity and in eight at 1,000 r.p.m.

The total number of first inseminations with separated spermatozoa was 142, resulting in 63 calves (fertility 44·4 per cent). Compared with the fertility (60·5 per cent) of the corresponding control group (104 pregnancies from 172 first inseminations) this figure is rather low ($\chi^2 = 8{\cdot}26$, $P < 0{\cdot}01$). Of the 63 calves, 36 were females and 27 males (sex ratio 42·9). The sex ratio of this total group does not deviate significantly from the normal one for cattle (106 : 100)[2]. However, a review of the different experiments reveals a considerable variation in fertility, a high proportion of females being apparently associated with high fertility. Therefore the experiments were pooled in two groups, one with fertilities equal to or more than 50 per cent, and the other with fertilities less than 50 per cent. The fertilities for these two groups, 63·8 and 31·0 per cent, respectively, differ significantly ($\chi^2 = 14{\cdot}99$, $P < 0{\cdot}001$).

Of the calves belonging to the first group 28 were females and 9 males (sex ratio 24·3). The corresponding figures of the second group are 8 and 18 (sex ratio 69·2). Also the sex ratios of these two groups differ significantly ($\chi^2 = 12{\cdot}57$, $P < 0{\cdot}001$). This means that the spermatozoa of certain samples are damaged by the counter-streaming centrifugation, and that thereby the female-determining spermatozoa are more sensitive than the male-determining ones. Most probably the factor causing this damage is mechanical stress. This idea is supported by the fact that two groups of experiments which have been pooled according to the r.p.m. used differ significantly as to fertility (pooled samples separated at 1,000 r.p.m. : 53·6 per cent; pooled samples separated at 1,100 r.p.m. : 35·6 per cent; $\chi^2 = 4{\cdot}66$, $P = 0{\cdot}05$), the high velocity having decreased the fertility more than the low one.

In the light of the present results, the male predominance in the earlier experiments is more easily understood; the spermatozoa were submitted to 1,100 r.p.m. in these experiments.

The group of pooled experiments, having a fertility equal to or higher than 50 per cent, shows a sex ratio which deviates significantly from the normal one of cattle ($\chi^2 = 9{\cdot}31$, $P < 0{\cdot}01$). It thus seems possible to select viable-determining spermatozoa by running the counter-streaming centrifuge at a moderate speed.

In another series of experiments the spermatozoa most difficult to sediment were isolated at 1,100–1,200 r.p.m., and used for inseminations. Here also the female-determining spermatozoa have been eliminated more frequently than the male-determining ones in connexion with decreased fertility. No accumulation of male-determining spermatozoa could be detected in this fraction.

A more detailed account of this work will be published in *Acta Agriculturae Scandinavica*.

Financial assistance from the Swedish Agricultural Research Council is gratefully acknowledged. I am very much indebted to the A.I. Association of Enköping for allowing me to perform these experiments, and to the chief veterinarian, Dr. T. Svensson, and to Dr. K. Idla for most valuable co-operation. The counter-streaming centrifuge was run by Mr. P.-Å. Lindström. All information on the calves was collected by Miss G. Thelin.

Per Eric Lindahl

Institute of Zoophysiology,
Upsala.
Dec. 14.

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Structural Differentiation in the Nucleoid of Mature Vaccinia Virus

It has been known for some time that mature virus particles of the pox group contain a brick-shaped central body, or nucleoid, surrounded by an outer layer of protein[1]. The fact that in pepsin-treated particles this nucleoid cannot be hydrolysed by deoxyribonuclease alone, but only by deoxyribonuclease followed by a further pepsin digestion, has been taken as an indication that the nucleoid itself contains protein as well as nucleic acid[2]. However, when mature vaccinia virus particles are examined with the electron microscope in thin sections after either osmium or ethanol–acetic acid fixation, the nucleoid presents a more or less homogeneous appearance[3].

In order to investigate further the nucleoidal structure of this type of virus, samples from pellets of purified vaccinia virus particles were dehydrated and embedded in methacrylate for thin sectioning, after fixation with buffered osmium-sucrose[4,5] at *p*H 7·6 or potassium permanganate[6] at *p*H 7·6, for about 1 hr.

Examination of the osmium-fixed particles served to give a point of departure for the work and confirmed the observations of Peters[3] on the general structure of the mature virus and the homogeneity of its nucleoid.

On the other hand, permanganate-fixed particles, although showing an overall internal arrangement similar to the foregoing, exhibited in addition two new features of interest. First, the outer zone of the virus, lying between the outer double-limiting membrane and the double membrane surrounding the nucleoid, appeared both much narrower and considerably less electron dense than in material fixed with osmium (Fig. 1); it is this zone which is usually considered to consist of the peripheral protein layer of the virus[3]. Secondly, and more important, the brick-shaped nucleoid within its double membrane was found to be strikingly differentiated into an inner and an outer region; the electron density of the former was great and that of the latter was slight (Fig. 1), being very similar in this respect to the peripheral protein layer of the virus. In view of this similarity, it is possible that the less electron-dense region lying within the double membrane surrounding the nucleoid might represent the protein constituent of this part of the virus, the nucleic acid corresponding perhaps to the very electron-dense

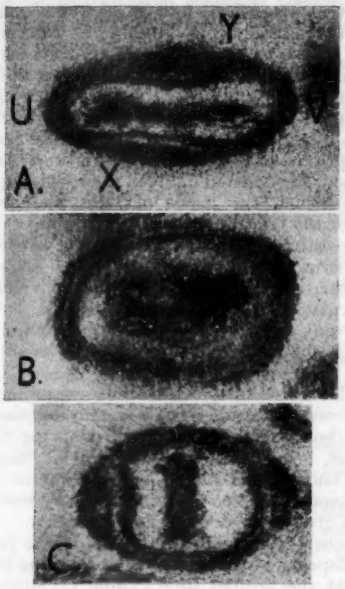

Fig. 1. Thin sections of mature vaccinia virus particles cut in various planes. *A*, Longitudinal section across the shortest dimension of the particle. *B*, Longitudinal section across the longest dimension of the particle; this is at right angles to plane of section *A*, along the line *U*—*V*. *C*, Transverse oblique section along the line *X*—*Y* shown in *A*. Permanganate fixation for about 1 hr. × 120,000. Note in particular the nucleoid within its double membrane showing a central electron-dense disk with a less dense region round about

disk in the centre. However, whatever the answer to this question may ultimately prove to be, the difference in response to permanganate fixation shown by different regions of the nucleoid of mature vaccinia virus particles reflects a definite underlying structural differentiation.

M. A. Epstein

The Bland–Sutton Institute of Pathology,
The Middlesex Hospital,
London, W.1. Dec. 19.

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Effect of Glycerol and Low Temperature on Survival of Unfertilized Mouse Eggs

Some unfertilized eggs of the rabbit are still fertilizable subsequent to cooling to temperatures as low as 0° C.[1]. In our attempts to preserve unfertilized mouse eggs at temperatures above and below freezing we have discovered that some of these germ cells survive exposure to −10° C.

The technique of transplanting unfertilized eggs from one female to another was employed in evaluating survival of these cells. Eggs obtained by induced ovulation of immature brown *C57* females were experimentally treated prior to transplanting them into fertile, mated Bagg Albino (*BALB/c*) recipients where eye colour of the fœtuses served to identify them[2]. The medium used was modified Locke's solution (distilled water, 500 ml.; sodium chloride, 3·38 gm.; calcium chloride, 0·09 gm.; potassium chloride, 0·16 gm.; sodium bicarbonate, 0·05 gm.; dextrose, 0·36 gm.) containing 5 per cent glycerol by volume. Eggs were placed in 0·3 ml. of the medium in each of the 1·5-ml. glass ampoules used as containers. The ampoules, sealed by flame, were then clipped to fibre-glass canes which were immersed in an alcohol bath cooled to −10° C. by pieces of solid carbon dioxide. Glycerol facilitated supercooling and under these conditions the medium was free from ice at −10° C. during the storage periods. The experiment involved the transplantation of 180 eggs into 30 recipients. Results are summarized in Table 1.

Table 1. Survival of Unfertilized Mouse Eggs exposed to −10° C.

Exposure time (hr.)	No. of recipients		No. of transplanted eggs in pregnant recipients		
	Total	Pregnant	Total	Developed	Survival (per cent)
½	12	8	48	8	17
2	13	7	42	3	5
6	5	4	24	0	0

In the light of current knowledge, the presence of glycerol in a medium designed to favour low-temperature preservation of germ cells seems desirable, perhaps essential. This substance has been found to favour survival of certain mammalian spermatozoa during cooling to and rewarming from sub-freezing temperatures[3]. Although its role as a protective substance against temperature shock in cooling above the freezing temperature is still not evaluated[4], its presence is compatible with survival of unfertilized mouse eggs[2] cooled to 5° C. There is some evidence that exposure of bull spermatozoa to glycerol at 5° C. enhances fertilization following insemination by them[5]. On the contrary, glycerol is said to be responsible for inhibition of fertilization in the fowl during the customary intravaginal insemination of glycerolated semen[6,7]. We recently reported that unfertilized mouse eggs shrank irreversibly at 5° C. in 5 per cent glycerol prior to transplantation, without deleterious effect[2]. According to permeability studies with other cells[8], this would indicate non-penetration by glycerol. We suggested that eggs might re-expand with the penetration of glycerol at the higher temperature in the recipients but this was not investigated. It was decided to ascertain whether or not the presence of glycerol within unfertilized mouse eggs is compatible with their survival as tested by production of normal progeny in the technique of egg transplantation.

Preliminary experiments showed that when eggs are placed in media containing 5 per cent glycerol by volume at 37° C. they shrink initially but quickly re-expand within 8–10 min. Therefore, eggs were exposed to 5 per cent glycerol in modified Locke's solution for 15 min., to ensure penetration, prior to transplantation. Samples of a harvest of eggs from which experimental eggs were obtained were inspected microscopically to check re-expansion phenomenon in each experiment. This phase included 10 recipients and 60 eggs, numbers sufficient for qualitative but not quantitative evaluation as to effect on fertility. Six out of the ten animals became pregnant. Autopsy of these six animals near term revealed that 14 per cent of these glycerol-containing eggs produced apparently normal progeny.

These results establish that: (1) some unfertilized mouse eggs can be cooled to, and stored at, −10° C. for at least 2 hr. in an ice-free medium without loss

of functional activity; (2) the presence of glycerol within unfertilized mouse eggs does not prevent their fertilization and subsequent normal embryonic development.

Further details of this work will be included in our subsequent report on temperature shock and hypothermia in unfertilized mouse eggs which will appear elsewhere.

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J. K. Sherman
Teh Ping Lin
American Foundation for Biological Research,
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Influence of Time of Mating on the Segregation Ratio of Alleles at the *T* Locus in the House Mouse

The series of recessive alleles (*t* series) that have been shown to occur at the *T* locus in the house-mouse have aroused considerable interest because of their widespread distribution[1], their effects on embryonic differentiation[2], and their effect on the segregation ratio in males[3,4]. Males that are heterozygous for one *t* allele (that is, $+/t$ or T/t) have been found to sire litters in which the proportion of offspring carrying the *t* allele differs markedly from that expected on the basis of normal Mendelian ratios. In most instances the number of offspring inheriting the *t* allele is greatly in excess of expectation, but with certain *t* alleles the number may be lower than normal. The segregation ratio in females of these genotypes is normal.

Bryson[5] could find no evidence in favour of the suggestion[2] that the segregation ratio abnormality was the result of extra divisions in those spermatids that bore the *t* allele. Other hypotheses that have been put forward[3,6,7] have involved meiotic irregularities or gene conversion; but there is as yet no evidence to support them. Working on the assumption that the mechanism involved in this abnormality was of a physiological rather than a cytological nature and that it came into action only after the sperm had been introduced into the female genital tract, a study was made of the effect of varying the time of coitus in relation to the time of ovulation on the segregation ratio of the alleles *T* and *t*.

Outbred Swiss albino female mice were mated with males of the genotypes T/t^9, T/t^1, T/t^3 and T/t^{12}. Some of the females were caged continuously with a male (three females/male) so that coitus would occur at the normal time (which is about 5 hr. before ovulation[8]); other females were only permitted coitus during a 3-hr. period commencing several hours after the approximate time of ovulation—these are designated 'late-mated'. The mice were kept in a room in which the times of light and dark were automatically controlled so that the time of ovulation could be estimated[4,8]. In mice mated at the normal time, sperm penetration of the eggs begins about 8 hr. after coitus; but in mice mated several hours after ovulation this interval is only about 1 hr.[8]. The normal and late matings were carried on concurrently, that is, males were taken from the 'normal mating' pens for a 3-hr. period each day and placed in the 'late mating' pens. The segregation ratio of *t* and *T* was determined by examining the tails of the new-born offspring: in $+T$ offspring the tail is shortened, but it is normal in $+t$ mice. Many of the females had several litters so, in order to minimize any differences due to the females, they were used in different groups in successive pregnancies.

With each of the eight males tested the proportion of $+t$ offspring was lower after late mating than after mating at the normal time (Table 1), and with one exception the results from each male were highly significant. The mean litter size in the two groups was very similar (about 8·0). The reason for the insignificance of the difference between normal and late mating with male *C* is not clear. It is possibly related to the low fertility of this male—less than half of the females with which he copulated had litters. Two other features of the results should be noted. First, males of the same genotype tended to have very similar segregation ratios and, secondly, the segregation ratio of the T/t^3 male was normal (approximately 1 : 1) in normally mated females, but after late mating the proportion of $+t$ offspring was much reduced ($31 + t : 69 + T$).

These results suggest that the mechanism of the male segregation ratio abnormality in mice carrying a *t* allele has a physiological rather than a cytological basis, and that its time of action is between ejaculation and fertilization. It is not possible at this juncture to be more specific as to the nature of the mechanism. There are many possible hypotheses; but some of them have become unlikely as a result of concurrent studies on the infertility of males carrying two *t* alleles[10]. Further work is in progress. The present results provide evidence in support of the suggestion by earlier workers that the function of a sperm in the female genital tract may be affected by a single genetic locus in such a way that its chances of fertilizing an egg are radically altered. This finding has

Table 1. The Male Segregation Ratio of the Alleles *t* and *T* after Normal or Late Mating

Male	Genotype	Normal mating				Late mating				Significance of difference
		No. of litters	No. of offspring $+t$	No. of offspring $+T$	Ratio	No. of litters	No. of offspring $+t$	No. of offspring $+T$	Ratio	
A	T/t^1	11	53	16	77 : 23	9	39	35	53 : 47	$P < 0{\cdot}01$
B	T/t^1	12	54	18	75 : 25	11	40	34	54 : 46	$P < 0{\cdot}01$
E	T/t^3	11	90	22	80 : 20	9	42	26	62 : 38	$P < 0{\cdot}01$
G	T/t^3	8	58	10	85 : 15	10	52	36	59 : 41	$P < 0{\cdot}001$
C	T/t^{12}	9	40	5	89 : 11	9	71	13	84 : 16	N.S.
F	T/t^{12}	6	55	6	90 : 10	3	10	6	63 : 37	$P < 0{\cdot}01$
I	T/t^{12}	8	67	5	93 : 7	5	29	12	71 : 29	$P < 0{\cdot}005$
D	T/t^9	12	61	59	51 : 49	6	17	38	31 : 69	$P < 0{\cdot}02$

a bearing on quantitative genetical theory, for one of the premises of this theory is that there is random union of gametes.

This investigation was supported by a grant from the Committee for Research in Problems of Sex, National Academy of Sciences—National Research Council, and in part by a research grant (*B*931) from the National Institutes of Health, Public Health Service, to Dr. S. Gluecksohn-Waelsch. I wish to thank Prof. E. Scharrer for the hospitality of his Department, and Dr. S. Gluecksohn-Waelsch for much valuable advice and help.

A. W. H. Braden*

Department of Anatomy,
Albert Einstein College of Medicine,
New York 61.

* Fulbright Research Scholar. Permanent address, Commonwealth Scientific and Industrial Research Organization, Sheep Biology Laboratory, Prospect, New South Wales.

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Survival Curves for Male and Female House-Flies (*Musca domestica* L.)

During the course of a study on the biochemical changes accompanying ageing in the adult house-fly, the attention of the senior author was directed to the differential longevities of the male and female members of the common house-fly, *M. domestica* L. Paradoxically enough, a search of the literature revealed only scattered and inconclusive information on the longevity of this species under controlled laboratory conditions. Several authors have been cited by Roubaud[1] to the effect that the longevity of the house-fly can be extended to as much as 90 days by exposure to temperatures of 15° C. (59° F.); West, on the other hand[2], states in no convincing terms that the longevity of the house-fly varies from two to three weeks, at most, during the summer and up to three months during the winter months. A side study was therefore undertaken to obtain reliable vital statistics for the male and female members of this species, bred, reared and maintained under standardized laboratory conditions. This report will summarize briefly one phase of this study to be published, *in extenso*, at a later date.

The flies studied represent offspring from many generations of inbreeding of (standard laboratory strain) *NAIDM* flies from the Technical Development Laboratories of the United States Public Health Service (through the kind co-operation of Dr. Albert S. Perry). Results summarized in this communication cover more than 4,000 members of each sex (more than 8,500 flies in all), through nine successive generations; all were maintained, bred and reared (and permitted to age) at 80° F. and 45 per cent relative humidity in our laboratory as described earlier[3]. Eggs were collected from a standard medium when the parents were 4½–5 days old. Offspring were reared on this medium[3] and, under these conditions, emerged as adults exactly 14 days after the first appearance of the parent flies. Parents, as well as ageing flies, were maintained on a powdered whole-milk, sucrose and water diet (*ad libitum*) in bronze screen cages 7½ in. × 7½ in. × 16 in., under temperature and humidity conditions indicated above, in numbers of 150–200 of each sex per cage.

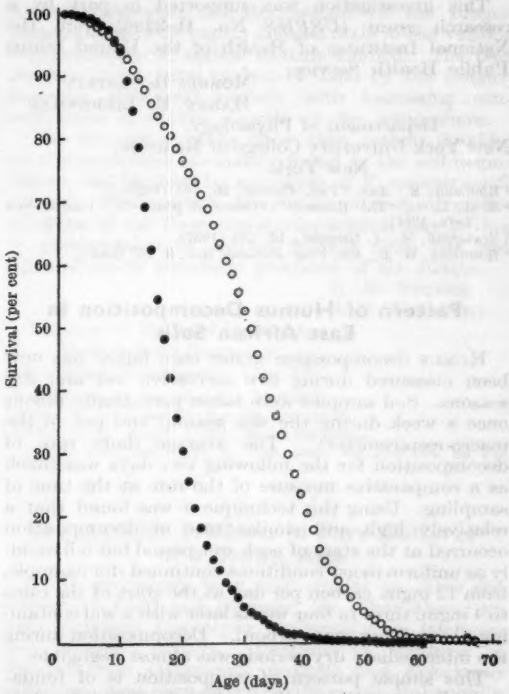

Fig. 1. Survival curves of male and female house-flies. ●, Males; ○, females

Fig. 1 shows the survival curves for each sex. These clearly suggest a typical, rectangular form of survival curve representative of animal populations showing senescence (that is, slow rate of death of youthful members of the population followed by an acceleration of mortality during a specific period of the life-history). However, during the final days of adult life this species exhibits a logarithmic-like survival curve with a markedly retarded rate of dying off (40–60 days for the male and 55–70 days for the female). The marked difference in average and maximum longevities of the two sexes is apparent from an examination of the two curves. Thus, about 90 per cent of the males die between ten and thirty days of age, whereas the females die off to the same extent between the tenth and fiftieth day of adult life. What had been observed earlier for only 600 pairs of flies[3] has held true for more than 4,000 flies of each sex through nine successive generations; namely, that at thirty days of age 50 per cent of the females have survived; by the end of this same period of time only about 5 per cent of the males are still alive (indeed, 50 per cent mortality for males occurs at about 16 days of age). In actual longevity figures, males had a mean longevity of 17·4 and a maximum of 54 days; females had a mean longevity of 29·4 days and a maximum of 63 days. Such data clearly confirm the rather widespread occurrence of higher female longevity in animal species discussed elsewhere by Hamilton[4] and Rockstein[5].

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Morris Rockstein
Harry M. Lieberman

Department of Physiology,
New York University College of Medicine,
New York.

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Pattern of Humus Decomposition in East African Soils

Humus decomposition under bare fallow has now been measured during five successive wet and dry seasons. Soil samples were taken periodically (about once a week during the wet season) and put in the macro-respirometer[1]. The average daily rate of decomposition for the following two days was taken as a comparative measure of the rate at the time of sampling. Using this technique it was found that a relatively high and similar rate of decomposition occurred at the start of each wet period but fell rapidly as uniform moist conditions continued (for example, from 12 mgm. carbon per day at the start of the rains to 4 mgm. three to four weeks later with a soil containing about 6 per cent carbon). Decomposition during the intermediate dry periods was almost negligible.

This simple pattern of composition is of fundamental importance. Since decomposition involves nitrate production it puts soil nitrogen availability on a more predictable basis and emphasizes the importance of timing in planting. This should be done before the start of the rains, or as soon after as possible, when nitrate production is at a maximum, rather than later, when production is much slower and losses of nitrate produced earlier may have occurred through leaching. The pattern also shows that humus decomposition proceeds spasmodically according to the drying and wetting cycle and involves, on each occasion, the rapid decomposition of discrete amounts of humus rather than the slow decomposition of the humus fraction as a whole (see below). An appreciation of this behaviour, and the slow rate of decomposition which may be reached under steady moist conditions, should be of value in work involving humus depletion and build-up. The persistence of this behaviour has been demonstrated in laboratory experiments with the same soil. After forty successive oven-drying and rewettings, with decomposition after each rewetting, the flush of decomposition still occurs, but is declining in magnitude as the reserve of decomposable organic material gets less. So far about 35 per cent of the total soil carbon has been decomposed in this way.

Recent work has shown that while an air-dry soil saturated with different bases gave very different amounts of soluble organic material (10 gm. soil extracted with 40 ml. water), the magnitudes of decomposition (100 gm. soil at field capacity) were almost identical. Similar results, but of greater magnitude, were obtained with the oven-dry soils.

	Air-dry			Oven-dry		
	Na	K	Mg	Na	K	Mg
mgm. organic nitrogen/10 ml. extract	0·44	0·26	0·12	0·43	0·40	0·20
mgm. carbon decomposed in 16 days	77·7	77·7	76·4	113·9	120·6	123·3
*p*H	6·3	6·6	7·1	6·3	6·8	6·9

Evidently decomposition involves the humus itself, is little affected by the base present and is not dependent on the preliminary solution of organic material. It appears from this, and further evidence to be published elsewhere, that the drying effect is due almost entirely to its influence on the microbial population. In this respect the uniform pattern of decomposition following each successive drying and rewetting is noteworthy. Since there is ample available substrate, as shown by the frequency with which the drying effect occurs, the rapid fall-off in the rate of decomposition after each rewetting may be due to the development of unfavourable conditions. Alternatively, the same bacterial culture cycle may follow each re-wetting, with high metabolic and enzyme activity during the early phase (characterized by high uptake of oxygen, evolution of carbon dioxide and production of ammonia) falling off during the stationary phase and period of decline. Heat activation of spores may also be involved, and these possibilities are being investigated.

This repetitive behaviour of humus decomposition emphasizes the importance of the wetting and drying cycle in soil fertility. This is particularly marked with nitrate production but other elements such as bases and phosphorus are similarly affected[2]. The behaviour of the soil as regards nutrient supply is clearly very different at the start of the rains from what it is later on, and in soil fertility studies this dynamic aspect of nutrient supply must be considered in conjunction with soil data obtained by conventional methods of analysis.

H. F. Birch

East African Agriculture
and Forestry Research Organization,
P.O. Box 21, Kikuyu, Kenya.

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Effect of Carbon Dioxide on Multiplication of *Fusarium* in Soil

Numerous studies have been made on the effects of carbon dioxide on fungal growth in pure culture, and on substrates other than soil. Since soil is the natural habitat of many fungi, and frequently has carbon dioxide-levels exceeding that present in normal air, it is important that effects of carbon dioxide-enriched air on fungal behaviour in soil be investigated. With the exception of work by Lundegårdh[1] using sterile soil and *Fusarium* species, there is little information available on the effects of carbon dioxide on fungal behaviour in soil. Recently, techniques have been developed[2] for studying *Fusarium* multiplication in natural soil, as indicated by sporulation and increase in number of colonies on soil dilution plates. It was found that carbon dioxide at levels of 2–25 per cent in air for 16–42 hr. frequently stimulated multiplication of *Fusarium oxysporum* f. *cubense*[3]. Studies were initiated with other *Fusarium* species and with carbon-14 dioxide to determine the action of carbon dioxide in stimulating *Fusarium* multiplication. The soil-plate technique[2] was used for studying the effect of carbon dioxide tension on *Fusarium* population as determined by soil dilution plating.

Certain *Fusarium* species in artificially infested loam and sandy loam (*p*H 5·6 and 7·4) were exposed for 42 hr. to normal air and air enriched with 4 per cent carbon dioxide, after moistening the soil with a

Table 1. STIMULATION OF MULTIPLICATION OF *Fusarium oxysporum* IN SOIL PLACED IN AIR ENRICHED WITH 4 PER CENT CARBON DIOXIDE

(Average *Fusarium* colonies per ml. of 1 : 1,000 soil dilution)

Culture	Soil incubated in* Air	Air + 4% CO_2
F. oxysporum f. *lycopersici*	0·8	5·0
F. oxysporum f. *nicotianae*	3·6	18·2
F. oxysporum f. *cucumerinum*	1·6	14·4

* 1 gm. of infested soil moistened with 1 per cent glutamic acid and dilution plates made 42 hr. later.

1 per cent solution of glutamic acid. The species used were : *F. oxysporum* f. *lycopersici*, *F. oxysporum* f. *nicotianae*, *F. oxysporum* f. *cucumerinum*, *F. solani* and *F. roseum*. The forms of *F. oxysporum* were isolated from their respective hosts and *F. solani* and *F. roseum* were isolated from the soil. Results of a representative experiment are shown in Table 1.

In about two-thirds of the experiments performed over a one-year period obvious stimulation of *Fusarium oxysporum* forms occurred in air enriched with 4 per cent carbon dioxide in contrast to normal air.

The behaviour of *F. roseum* and *F. solani* in air enriched with 4 per cent carbon dioxide was more erratic than *F. oxysporum*. In a few instances stimulation was evident but usually there was no stimulation. Apparently these species are less sensitive to the effect of carbon dioxide and/or other soil factors influencing multiplication than *F. oxysporum*. At concentrations up to 25 per cent carbon dioxide in air for 48 hr. there was no evidence of inhibition of survival or multiplication in soil of the *Fusarium* species studied.

To determine if carbon dioxide was being fixed by the fungus, studies were initiated with carbon-14 dioxide and *F. oxysporum* f. *cubense* freshly isolated from diseased bananas. A spore suspension of *F. oxysporum* f. *cubense* was added to 5 ml. of medium in 50 ml. beakers placed in stoppered 920-ml. Mason jars. The medium contained 10 gm. NH_4NO_3, 5 gm. KH_2PO_4, 2·5 gm. $MgSO_4.7H_2O$, 0·02 gm. $FeCl_3.6H_2O$ and 50 gm. sucrose per litre of distilled water, and after autoclaving was at *p*H 4·0. 10–100 μc. of carbon-14 labelled sodium carbonate was then introduced to the bottom of the jars around the beakers and 25 per cent perchloric acid added to release carbon dioxide. The capped jars were sealed with modelling clay. The cultures, thus exposed to radioactive carbon dioxide, formed a large pellicle of fungus in about four days. The resulting pellicles were removed and thoroughly washed with distilled water on filter paper. The washed pellicles were dried at 70° C. in a forced-draft oven, weighed and then ground in a mortar. Each ground pellicle was then thoroughly mixed with sufficient dried banana leaf tissue to make 1 gm., placed in a steel cup planchet and its radioactivity measured. Counts per min. of known quantities of carbon-14 in 1 gm. of banana leaf tissue had previously been determined[4] so that it was possible to estimate the quantity of carbon-14 incorporated by the fungus in the above samples. Two identical experiments were conducted and the results are shown in Table 2.

The total quantity of carbon-14 fixed by the fungus increased with increasing concentration of carbon dioxide, although the dry weight of the fungus (approximately 31 mgm.) differed little in the various concentrations of carbon dioxide studied. The percentage of the total carbon-14 fixed by the fungus, however, decreased slightly with increasing concentration of carbon dioxide in the atmosphere.

Table 2. CARBON DIOXIDE FIXATION BY *Fusarium oxysporum* f. *cubense*

Volume per cent CO_2 in jar	$^{14}CO_2$ (μc.)	Radioactivity in fungus in counts per min. Exp. 1	Exp. 2	Average	Total supplied radioactivity in fungus (per cent)
2·26	100	2,315·8	2,783·7	2,549·8	2·46
1·16	50	1,401·2	1,714·9	1,558·8	3·00
0·48	20	770·6	732·2	751·4	3·62
0·03	0	47·4	34·1	40·8	—

The foregoing results show that carbon dioxide, at concentrations commonly found in the soil atmosphere, can be fixed by mycelium of *F. oxysporum* f. *cubense*. Thus carbon dioxide stimulation of multiplication of the *Fusarium* species studied may be due to participation of carbon dioxide from the soil atmosphere in metabolic processes of the fungus.

R. H. STOVER
S. R. FREIBERG

Division of Tropical Research,
United Fruit Company,
La Lima, Honduras. Dec. 12.

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Extracellular Products in Pure Cultures of a Brown Alga

USING antibiotics in a way similar to those described by Fish[1] and Spencer[2] for other algae, we have obtained *Ectocarpus confervoides* in bacteria-free uni-algal culture. Bacteria-free cultures of Phaeophyceae (*Waerniella lucifuga* and *Ectocarpus parasitica*) have been grown by Provasoli, McLaughlin and Droop[3], but these do not appear to be particularly suitable for physiological study. It is clearly desirable that studies with pure cultures should be made if exact information about the metabolism of this group of algae is to be obtained.

In natural sea water enriched with nitrate, phosphate, iron and manganese, *E. confervoides* has a mean doubling time, in the early stages of growth, of about one week at 20° C. and a light intensity of 6,000 lux. Growth continues slowly for up to 30 weeks, according to the volume of the cultures, giving final yields of about 0·9 gm. dry weight per litre. In such cultures the medium becomes coloured distinctly yellow-brown after three weeks. Following up this indication, an investigation has been made of the extracellular products liberated by *E. confervoides* in pure culture.

The absorption spectrum, as determined with a 'Unicam *SP* 500' spectrophotometer, of the yellow-brown medium from an 11-week culture, after filtration through a sintered glass funnel of porosity 15–40μ, is shown in Fig. 1, curve *A*. After extraction with ether, material having an absorption maximum at 260 mμ remained in the aqueous phase (Fig. 1, curve *B*). The ether extract was yellow in colour with an absorption maximum in the region of 400 mμ (Fig. 1, curve *C* ; vertical scale × 8 that for curves *A* and *B*).

Filtrate from a 5-week-old culture, containing about 7 mgm. cell nitrogen per litre, after concentration and desalting by a method of electrodialysis, gave a positive reaction with ninhydrin, indicating the presence of about 0·15 mgm. α-amino-nitrogen per litre of the original medium. After hydrolysis with an equal volume of 50/50 concentrated hydrochloric acid and glacial acetic acid for 24 hr. at 105° C., 0·2 mgm. α-amino-nitrogen were found. This suggests that the view of Fogg and Westlake[4], that

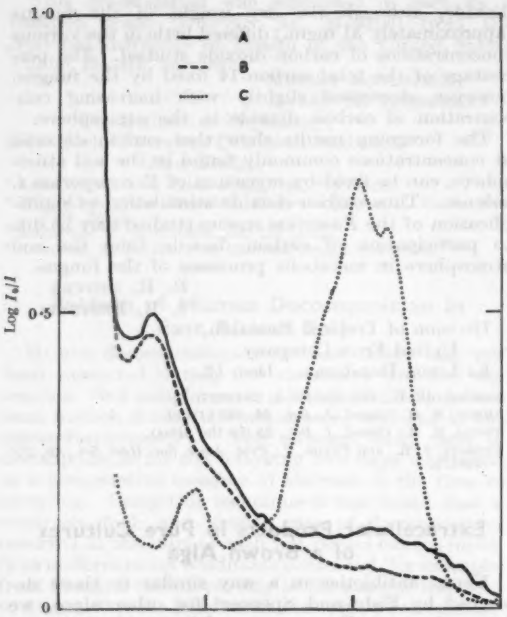

Fig. 1

extracellular nitrogenous compounds are liberated to an appreciable extent by most algae, applies to marine as well as freshwater species. It seems likely that this nitrogenous material is responsible for the absorption at 260 mμ observed in *E. confervoides* media after extraction with ether, but its further characterization has been hampered by the difficulty of desalting the large volumes of sea water required.

Paper partition chromatography, using mixtures of methyl alcohol and toluene, showed the ether-soluble fraction to contain four pigments. In their absorption spectra and ether solubility these resemble carotenoids. It is possible to reconcile this with their solubility in water by supposing that they are protein–carotenoid complexes such as those obtained from the chloroplasts of higher plants by Nishimur and Takamatsu[5].

Separation on a powdered cellulose column gave three well-defined fractions, the first of which appeared to have two components. When attempts were made to transfer these from ether to distilled water it was found that they were readily photo-oxidized when in contact with water and air. However, the pigments appear to be stable in the cultures and in the filtered medium prior to ether extraction, and are also stable when dissolved in ether. This further indicates the presence of a complex in the medium which is broken down on ether extraction.

Spectrophotometric examination of the filtrates from cultures of different ages has shown that the amount of the water-soluble ether-insoluble material absorbing 260 mμ is proportional to the growth of the alga as measured by dry weight. The total amount of yellow ether-soluble material also increases with the age of the culture, but it seems from the less regular relationship that the proportions of the individual pigments liberated vary during the course of growth. It seems likely from this that both types of extracellular product are liberated from healthy cells.

Work directed to the further characterization of these extracellular products of *Ectocarpus* is in progress. Meanwhile, it seems worth recording these results in view of the current interest in dissolved organic substances in natural waters, as discussed by Lucas[6], Saunders[7] and Vallentyne[8]. It is possible that extracellular nitrogenous compounds such as those of *Ectocarpus* contribute to the dissolved organic nitrogenous material present in sea waters, the ecological importance of which as a chelating agent may be considerable. No yellow pigments exactly corresponding with those liberated by *Ectocarpus* appear to have been recorded in sea water, although the absorption spectrum[9] of the 'yellow substance' found in neritic waters by Kalle has some resemblance to that of one of the components of the ether-soluble fraction.

We are grateful to the Development Commission for a grant made to one of us (G. T. B.), which has enabled this research to be carried out.

G. E. Fogg
G. T. Boalch

Botany Department,
University College,
Gower Street,
London, W.C.1.
Dec. 17.

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A Freshwater Mutant of *Balanus amphitrite*

A few species of animals which were known to be marine have become freshwater dwellers. An example of these freshwater mutants is the gastropod *Hydrobia jenkense* which, according to Ellis[1], was known to have been confined to brackish waters until the early part of the last century and is now abundant in freshwater in many parts of Great Britain and seems to be spreading widely in continental Europe.

The limiting ecological factors of the freshwater environment are only survived by mutant types of marine animals which were endowed with proper thermo- and osmo-regulation systems and a totally embryonic development. The absence of such adaptive mutations, or their inaccessibility to freshwater, from whole phyla such as Echinodermata, or whole classes of phyla such as Cephalopoda and Cirripedia, have made their representatives still exclusively marine.

In the north-east of the Nile Delta, some 40 miles south of the mouth of the river, freshwater from the Damietta branch of the Nile is constantly pumped by powerful machines during the floodless season (November–July) through a deep cement-built tank for the irrigation of a large area of land. The machines stop during the flood season (August–October) and the water in the tank falls to the level of the Nile. When the tank was studied for its fauna in

Fig. 1. *Balanus amphitrite* var. *denticulata*. (× 25)

July 1954, the walls and rocky floor were found densely populated with colonies of barnacles. Fixed specimens were identified by Dr. J. P. Harding of the British Museum (Natural History) as *Balanus amphitrite* var. *denticulata* Broch[2]. Broch's specimens, described in 1927, came from the Suez Canal, where the salt beds make the salinity higher than that of the sea. Since then the variety has been found in a number of localities, including the coast of Great Britain. *Balanus amphitrite* is often carried on ships' bottoms.

When the tank was investigated in December of the same year, only dead shells the inner walls of which were stuffed with embryo-like structures were found (Fig. 1). The tank has since been visited at irregular intervals, but so far no live specimens have been recovered.

It is believed that the mutant barnacle is of a seasonal occurrence. It exists only in the presence of favourable environmental conditions and dies when unfavourable conditions prevail, leaving resting embryos which remain dormant until the favourable conditions return. The reason why live specimens ceased to be found is now being investigated.

H. H. Shatoury

Zoology Department,
Faculty of Science,
University of Alexandria.

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Microbenthos of the Shore at Whitstable, Kent

While the results of a study conducted in the period September 1953–November 1955 have now been analysed, the inevitable delay in publication makes a summary of the results obtained both of interest and use. The term microbenthos is taken to include all those forms which will pass through a 1-mm. sieve.

The sandy flats studied lie at a gradient of 1/600 and consist of fine sand of average depth 7 cm., overlying London Clay of indeterminate depth. Drainage is such that the shore is covered to a greater or lesser degree by surface water in every exposure period. The microfauna but not the microflora showed marked differences in distribution dependent on differences in the soil grade. The microbenthos exhibited a patchy horizontal distribution, while vertically diatoms, copepods and ostracods were confined or tended to be confined to the surface 4 mm. of soil, nematodes lived in large numbers below this level in the sand, but not in the London Clay, which acted as an effective barrier to further penetration. All groups had a maximum population in the surface 2 mm. of soil.

The fauna here is the richest so far recorded in an unpolluted area, being, in 1955, $5{\cdot}22 \times 10^6$ nematodes per sq. m., $7{\cdot}422 \times 10^5$ ostracods per sq. m. and $4{\cdot}863 \times 10^5$ copepods per sq. m., at the time of their respective seasonal maxima, and the constitution of the microfauna at Whitstable seemed to be markedly different from other recorded microfaunas.

Seasonal changes were investigated at a position on the shore with a 3-hr. exposure period. It was found that the nematodes always dominated the fauna, while the ostracods and copepods only reached a maximum when the nematodes had started to decline. Ostracods dominated the copepods in the autumn, winter and spring months but in summer the copepods were dominant over the ostracods. *Leptocythere pellucida* was the most abundant form of ostracod, while *Asellopsis intermedia* was the most abundant harpacticoid copepod at all times of the year.

The microfauna as a whole showed one seasonal maximum in numbers, the population changes showing a correlation coefficient of + 0·75 with the mean sea temperature at the 0·1 per cent level of significance. Not only is the breeding cycle dependent on temperature, but it was found that between 0° and 20° C. activity of the harpacticoid copepods increased, while, in the shore itself, if temperatures fell below a value about 4° C., the microfauna showed a marked downward migration. A positive reaction to light was exhibited by many members of the three major groups; in particular the harpacticoid copepods reacted positively at all light intensities investigated between less than 2- and 2,000-ft. candles.

With the methods used, only the nematodes were found to exhibit a tidal rhythm. All three groups, nematodes, ostracods and copepods, moved actively on the surface during exposure and in the main body of sea water when covered. Some species, both of microflora and microfauna, occurred in considerable numbers in the inshore plankton while other forms occurred exclusively in the shore. Zonation was of the extended nature expected of the microfauna of a shore with such a low gradient as the sandy flats at Whitstable.

E. J. Perkins

Scottish Home Department,
Marine Laboratory,
Victoria Road,
Torry, Aberdeen.

Absence of the Diego Blood Group and Abnormal Hæmoglobins in 92 Maoris

Recent investigations of Mongoloid populations have shown in some of them a high incidence of hæmoglobin *E* and of the Diego blood group. The highest frequencies of hæmoglobin *E* have been found in Siamese, Burmese and north-east Malaysians, and the highest frequencies of the Diego blood group in South American Indians, followed by Japanese, North American Indians and Chinese. Hæmoglobin *H*, although seen in some Greeks and in a Jordanian Arab, has in the majority of the still relatively few observations been found in people of Asiatic Mongoloid origin, notably Chinese and Siamese, and occasionally in Philippines and Malaysians. Lastly, thalassæmia or Mediterranean anæmia is now known not to be restricted to persons of Mediterranean origin, for the observation of a high incidence in Siamese[1] has been followed by similar reports from other

Asiatic populations, both non-Mongoloid and Mongoloid.

In the Australasian region so far no abnormal hæmoglobins have been found in 166 Australian aboriginals[2] and 56 Melanesians (Horsfall, W. R., and Lehmann, H., unpublished). No example of the Diego blood group has been found in 62 Australian aboriginals, 23 eastern Papuans, 74 natives of New Britain and 80 eastern Polynesians[3].

We have examined 92 Maoris, of whom 65 were not first-degree relations. There is considerable intermarrying and as the people investigated live in a small area it is likely that some of these 65 are also related. The aim has been to obtain a gene pool which represents Maoris without White admixture. 85 belonged to the Tuhoe and 7 to the Arawa tribe. All were examined for the Diego blood group and for hæmoglobins *E* and *H* as well as for other abnormal hæmoglobins which can be detected by the sickling test or by electrophoresis. Hæmoglobin *H* is unstable, and control experiments were made to exclude the possibility that it escaped detection under the conditions of our experiments. In 84 samples a search was made for evidence of thalassæmia by examining the cells morphologically, by determining the alkali-resistant fraction of the hæmoglobin and by searching for an increased proportion of hæmoglobin A_2.

No hæmoglobin *E*, *H* or any other abnormal hæmoglobin, no Diego blood group and no evidence of thalassæmia were found. Our findings distinguish these Maoris from the North and South American Indians so far examined, and from the Siamese, Burmese and Malaysians. It cannot be taken to distinguish them clearly from Indonesians, Dyaks and other South Asian Mongoloids. Hæmoglobin *E* and the Diego blood group have been found at low frequency in some of these populations, but it is more likely that this is due to their mixing with neighbours in whom these characters are common than to represent in them essential racial features. We hope to extend these investigations and to examine in the first instance a tribe in the Ruatoki area in the coming year.

It is noteworthy that the Diego factor has not been found so far, in view of Heyerdahl's theory of the American origin of the Polynesians.

H. Lehmann

St. Bartholomew's Hospital,
London, E.C.1.

A. North

Te Whaiti,
New Zealand.

J. M. Staveley

Central Laboratory,
Auckland Hospital,
Auckland, New Zealand.

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Carbon-14 Dated Palæoliths from Borneo

1957 excavations by the Sarawak Museum at Niah Great Cave, West Borneo, produced a succession of human phases from subsurface Bronze Age through 'Neolithic' polished axes and adzes (to 24 in.), then edge-ground and 'pebble' tools, and below these unworked flakes and blades; deeper again (below 72 in.) crude 'choppers', in the sense lately re-defined by Prof. H. J. Movius[1]. A preliminary report[2] lacked carbon-14 information from the lower levels. Now Prof. Hl. de Vries, of the Physical Laboratory, University of Groningen, Holland, who has kindly carried out all our tests, reports on a charcoal sample from about 100 in.:

GRO. 1339 39,600 ± 1,000 years (1957)

It is not yet possible exactly to co-ordinate crude depths with artefact stratification, owing to unevenness in Niah's enormous human (not geological) deposit. It is clear, however, that we are down into the Palæolithic on an orderly sequence, for the first time in south-east Asia. Other early stone-age finds in this area have been at geological or casually exposed sites, without clearly interrelated animal remains, bone, shell, fire and extraneous stone associations.

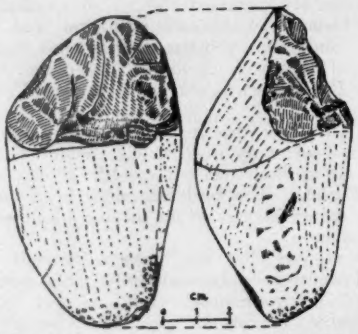

Fig. 1. Stone chopper from below 72 in. Niah Great Cave, Sarawak

The stone tools occurring between *GRO.* 1339 and a previous carbon-14 date (*GRO.* 1158) of 32,630 ± 700[3], are often uniface choppers, with hammer marks on the butts (Fig. 1). These closely parallel some from the 'Soan Culture' of north-west India, as figured by Dr. Kenneth Oakley[3]; five tools found on a gravel terrace in south-east Borneo[4]; and part of a recent collection from west Thailand[5], which I have examined in the National Museum, Bangkok. We should eventually be able to get a clearer idea of the Later Palæolithic in south-east Asia, using Niah stratified material as provisional yardstick, with further excavation in 1958 (thanks to a grant from the Calouste Gulbenkian Foundation of Lisbon[6]). It already seems that more caution should be exercised before attributing crude tools in any general way to the Lower Palæolithic in Asia—as has lately been done for the south-east Borneo pieces[4] and the Malayan 'Tampan'[7]—unless there is supporting evidence beyond the superficial look of the artefacts themselves.

Tom Harrisson

Sarawak Museum,
Kuching,
Sarawak.
Jan. 1.

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FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Monday, March 17

INSTITUTE OF METAL FINISHING (at the Northampton Polytechnic, St. John Street, London, E.C.1), at 6.15 p.m.—Mr. H. Cann: "Anodes".

Monday, March 17—Tuesday, March 18

SOCIETY OF CHEMICAL INDUSTRY, PESTICIDES GROUP (at 14 Belgrave Square, London, S.W.1), from 5.30 p.m. to 9 p.m. each day—Conversazione—"New Techniques in Pesticide Research".

Tuesday, March 18

PARLIAMENTARY AND SCIENTIFIC COMMITTEE, GENERAL COMMITTEE (in Committee Room 12, House of Commons, Westminster, London, S.W.1), at 5.15 p.m.—Discussion on "Space Satellites and Relevant Matters". Opening Speakers: Prof. A. C. B. Lovell, O.B.E., F.R.S., Prof. H. S. W. Massey, F.R.S., and Dr. D. H. Sadler, O.B.E.

ROYAL SOCIETY OF ARTS, COMMONWEALTH SECTION (at John Adam Street, Adelphi, London, W.C.2), at 5.15 p.m.—The Hon. F. W. Bulcock: "The Pastoral Industry of Australia".

INSTITUTE OF PHYSICS, ELECTRONICS GROUP (at 47 Belgrave Square, London, S.W.1), at 5.30 p.m.—Annual General Meeting, followed by Mr. L. A. Thomas: "Microwave Ferrites".

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, London, S.W.1), at 5.30 p.m.—Sir John Cockcroft, F.R.S.: James Forrest Lecture.

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.30 p.m.—Prof. W. E. Curtis, F.R.S.: "Magnetism". (Further lectures on March 19, 25 and 26. Lectures for Sixth Form Boys and Girls from Schools in London and the Home Counties.)

BRITISH INSTITUTION OF RADIO ENGINEERS (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 6.30 p.m.—Discussion on the Technical Committee's Report "Recommended Method of Expressing Electronic Measuring Instrument Characteristics. 1: A.M. or F.M. Signal Generators".

Wednesday, March 19

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2) at 2.30 p.m.—Sir Christopher Hinton, K.B.E., F.R.S.: "Industrial Power of the Future" (Trueman Wood Lecture).

ROYAL INSTITUTE OF CHEMISTRY (joint meeting with the LONDON BRANCH of the INSTITUTE OF BIOLOGY and the LONDON AND HOME COUNTIES BRANCH of the INSTITUTE OF PHYSICS, in the Sir William Beveridge Hall, Senate House, University of London, W.C.1), at 4.30 p.m.—Symposium on "Science and Society". Speakers: Prof. P. M. S. Blackett, F.R.S., Prof. L. T. Hogben, F.R.S., Prof. A. Haddow, Prof. Dame K. Lonsdale, F.R.S. and Mr. Anthony Smith.

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, London, S.W.7), at 5 p.m.—Scientific Papers.

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 5.15 p.m.—Sir Robert Shone and Mr. H. R. Fisher: "Industrial Production and Steel Consumption".

EUGENICS SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Symposium on "New Human Demands in Industry". Speakers: Mr. Alec Rodger, The Hon. Michael Layton, Mr. R. Peddie and Dr. K. Hutton*.

SOCIETY FOR ANALYTICAL CHEMISTRY, MICROCHEMISTRY GROUP (in the restaurant room of "The Feathers", Tudor Street, London, E.C.4), at 6.30 p.m.—Discussion Meeting on "The Microdetermination of C, H and N in the Presence of Interfering Elements (Metals and Non-metals)".

Thursday, March 20

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.15 p.m.—Meeting for Election of Fellows. 4.30 p.m.—Mr. L. Rotherham: "Atomic Energy Authority Industrial Group Research Organization (Dounreay Reactor)".

INSTITUTION OF MINING AND METALLURGY (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—General Meeting.

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. N. Jacobson: "Representation Theory for Jordan Algebras".

INSTITUTION OF MECHANICAL ENGINEERS, LUBRICATION GROUP (at 1 Birdcage Walk, Westminster, London, S.W.1), at 6 p.m.—Discussion on "How to Bridge the Gap between Theory and Practice in Lubrication".

SOCIETY OF CHEMICAL INDUSTRY, ROAD AND BUILDING MATERIALS GROUP (at 14 Belgrave Square, London, S.W.1), at 6 p.m.—Mr. G. M. Dormon and Mr. A. W. Jarman: "Some Factors Influencing the Behaviour of Bitumen Road Surfacings".

SCIENTIFIC FILM ASSOCIATION, SCIENCES COMMITTEE (in the Mezzanine Cinema, Shell-Mex House, Strand, London, W.C.2), at 6.30 p.m.—Meeting on "Recent Development in Research Film". Chairman: Dr. R. H. Brown, M.A.

ROYAL PHOTOGRAPHIC SOCIETY (at 16 Princes Gate, London, S.W.7), at 7 p.m.—Dr. B. H. Crawford and Dr. J. M. Burch: "The Use of Colloidal Photographic Emulsions in the preparation of Interference Filters and Diffraction Gratings".

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at the Royal Army Medical College, Millbank, London, S.W.1), at 7.30 p.m.—Laboratory Meeting. Chairman: Brigadier J. S. K. Boyd, O.B.E., F.R.S.

BRITISH INSTITUTE OF RADIOLOGY, incorporated with the Röntgen Society (at 32 Welbeck Street, London, W.1), at 8 p.m.—Dr. L. F. Lamerton: "An Examination of the Clinical and Experimental Data relating to Possible Hazard to the Individual of Small Doses of Radiation" (Presidential Address).

Friday, March 21

FACULTY OF RADIOLOGISTS (at the Royal College of Surgeons, Lincoln's Inn Fields, London, W.C.2), at 4.45 p.m.—Meeting on "Medical Problems associated with Applied Atomic Energy". Speakers: Dr. J. F. Loutit, Dr. A. S. McLean and Dr. J. D. Abbatt.

INSTITUTE OF NAVIGATION (at the Royal Geographical Society, 1 Kensington Gore, London, S.W.7), at 5.15 p.m.—Mr. E. J. Dickie, M.B.E.: "The Effective Utilization of Airspace".

INSTITUTION OF MECHANICAL ENGINEERS (at 1 Birdcage Walk, Westminster, London, S.W.1), at 6 p.m.—Dr. Ekhart Schmidt: "High-Speed High-Performance Diesel Engines—Their Development and Application" (James Clayton Lecture).

ROYAL PHOTOGRAPHIC SOCIETY (joint meeting with the ASSOCIATION OF PRINTING TECHNOLOGISTS, in the Lecture Theatre of the Science Museum, Exhibition Road, London, S.W.7), at 7.15 p.m.—Mr. M. Hepher: "Three Colour Lithography for Short Runs".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Prof. Cyril Dean Darlington, F.R.S.: "The Control of Evolution in Man".

Saturday, March 22

BRITISH SOCIAL BIOLOGY COUNCIL (at Victoria Hall (North), Bloomsbury Square, London, W.C.1), at 10 a.m.—Conference on "The Education of Scientists".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT LECTURER (qualified in either pure or applied mathematics) IN MATHEMATICS—The Registrar, University College of North Staffordshire, Keele, Staffs (March 21).

LECTURER or SENIOR LECTURER (male, British, with an honours degree in electrical engineering) IN THE PHYSICS AND ELECTRICAL ENGINEERING DEPARTMENT—The Director of Studies, Royal Naval College, Greenwich, London, S.E.10 (March 21).

PATENT OFFICERS (with an honours degree in science or engineering or equivalent qualifications, and preferably some patent experience) at the U.K.A.E.A. London Office and the Research Establishment at Harwell—The Establishment Officer, United Kingdom Atomic Energy Authority, 11 Charles II Street, London, S.W.1 (March 21).

LECTURER or ASSISTANT LECTURER IN PLANT PHYSIOLOGY (with special reference to metabolism and plant biochemistry)—The Secretary and Registrar, The University, Southampton (March 24).

RESEARCH OFFICER (veterinary surgeon, preferably with post-graduate laboratory experience) AT THE FARM LIVESTOCK RESEARCH CENTRE, Animal Health Trust, Stock, Essex, to specialize in diseases of pigs—The Scientific Director, Animal Health Trust, 14 Ashley Place, London, S.W.1 (March 24).

GUIDE LECTURER (with a university degree or equivalent qualification in geology, and preferably lecturing or teaching experience) AT THE GEOLOGICAL MUSEUM, London—Civil Service Commission, 30 Old Burlington Street, London, W.1, quoting Ref. No. S/4817/58 (March 27).

CHEMIST or BIOCHEMIST (with a good honours degree in chemistry or biochemistry) IN THE DEPARTMENT OF PLANT CELL BIOLOGY, to use and develop ultramicrochemical techniques—The Secretary, John Innes Horticultural Institution, Bayfordbury, Hertford, Herts (March 29).

PHYSICAL CHEMIST or BIOCHEMIST, for research work on special derivatives of viruses and on the preparation of virus crystals in conjunction with a team studying the structure of viruses by physical methods—The Secretary, Birkbeck College (University of London), Malet Street, London, W.C.1 (March 29).

SENIOR SCIENTIFIC OFFICER (with a first- or second-class honours degree in civil engineering or equivalent) at the Building Research Station (D.S.I.R.), Garston, Herts, for research on engineering design and construction of nuclear power plants, particularly in concrete and reinforced concrete—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting R.609/7A (March 29).

ASSISTANT ALGOLOGIST (with a degree in botany) at the Windermere Laboratory, for research in freshwater algology—The Director, Freshwater Biological Association, The Ferry House, Ambleside, Westmorland (March 31).

IMPERIAL CHEMICAL INDUSTRIES FELLOWS (preferably with the degree of Ph.D. or equivalent research experience), to carry out original research in Chemistry or Physics for a period not exceeding three years—The Registrar, University College of North Staffordshire, Keele, Staffs (March 31).

UNIVERSITY DEMONSTRATOR IN ORGANIC CHEMISTRY—Dr. F. B. Kipping, University Chemical Laboratory, Lensfield Road, Cambridge (April 2).

ZOOLOGIST (man, with a good honours degree and preferably post-graduate experience in marine ecology), to join, and eventually to

lead, a team studying plankton in relation to the herring, and duties will include occasional work at sea in fishing vessels and research ships—The Officer-in-Charge, Oceanographic Laboratory, Scottish Marine Biological Association, 78 Craighall Road, Edinburgh 6 (April 5).

Chief Technician in the Department of Physics, University College of Ghana—The Assistant Registrar (London), University College of Ghana, 29 Tavistock Square, London, W.C.1 (April 10).

Assistant Lecturer (suitably qualified graduate in chemistry or agricultural chemistry) in Chemistry—The Registrar, Wye College (University of London), near Ashford, Kent (April 12).

Electronics Technician (with a wide general knowledge of electronics, an interest in instrumentation, an inventive mind and the ability to accept responsibility) in the Department of Chemistry, for duties which will include the development and maintenance of special equipment for teaching and research—The Registrar, The Manchester College of Science and Technology, Manchester 1 (April 12).

Research Fellow and a Research Demonstrator in the Department of Chemistry—The Registrar, University College, Singleton Park, Swansea (April 12).

Research Student (graduate, preferably with qualifications in physical geography) in the Coastal Geography of Roman Britain, centred initially on the Thames Estuary—The Director and Secretary, Royal Geographical Society, 1 Kensington Gore, London, S.W.7 (April 14).

Lecturer in Mathematics, and a Lecturer in Philosophy at Acadia University, Wolfville, Nova Scotia, Canada—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (April 15).

Assistant in the Zoology Department and Gatty Marine Laboratory of St. Salvator's College—The Joint Clerk to the University Court, College Gate, St. Andrews (April 16).

Assistant Lecturer in Social Anthropology—The Secretary, London School of Economics and Political Science, Houghton Street, London, W.C.2 (April 16).

Imperial Chemical Industries Research Fellows in Chemistry, Engineering, Pharmacology or Physics—Joint Clerk to the University Court, College Gate, St. Andrews (April 19).

Technician in the Department of Physiology, University of Khartoum—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (April 20).

Chair of Education, with special reference to education in tropical areas tenable at the Institute of Education—The Academic Registrar, University of London, Senate House, London, W.C.1 (April 23).

Walter Myer and Everett Dutton Chair of Parasitology and Entomology—The Registrar, The University, Liverpool (April 26).

Chair of Geography—The Registrar, The University, Hull (April 30).

Research Fellow in the Department of Nuclear Physics, Research School of Physical Sciences, Australian National University—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, April 30).

English Electric Research Fellow for postgraduate research into the problems of vibration or stability and control of aircraft—The Warden, The College of Aeronautics, Cranfield, Bletchley, Bucks (May 1).

Mathematicians (2) (preferably with a Ph.D. degree in mathematics)—G. R. Magee, Department of Mathematics, University of Western Ontario, London, Ontario, Canada (May 1).

Professor (with high academic qualifications in science and experience in teaching or research) of Soil Science at Canterbury Agricultural College (University of New Zealand)—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, June 30).

Entomologist (under 35 years of age, a university degree (preferably honours) in entomology or zoology and postgraduate experience in applied entomology) in the Tsetse Control Department, Uganda, to conduct investigations into tsetse distribution and ecology in the field; plan and supervise tsetse surveys and control; and train junior staff—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.77/9/02.

Instructors and Assistant Professors (with the Ph.D. degree, or equivalent, in inorganic or physical chemistry) in the Department of Chemistry—Prof. C. A. McDowell, Department of Chemistry, University of British Columbia, Vancouver, B.C., Canada.

Lecturer (preferably qualified in some branch of applied physics) in Physics in the Department of Natural Philosophy—The Secretary, Royal College of Science and Technology, Glasgow.

Lecturer/Senior Lecturer (with a degree in pharmacy or a related subject) in Pharmacy at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, April 12).

Physicists (with a first- or second-class honours degree in physics and preferably a working knowledge of electronics and experience in one or more of the following fields: gas discharges, detonation processes or solid state physics), to undertake work in the field of electrical physics, devising novel items and proving their feasibility for special application—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berkshire, quoting Ref. A/1640/34.

Scientists (degree standard), for research into the application of existing sources of energy and the exploitation of new ones in the iron and steel industry—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting "F.T.5".

Senior Lecturer (with considerable practical experience in the rubber industry and professional and/or academic qualifications) in Rubber Technology; a Senior Lecturer (with laboratory and/or industrial experience of rubbers and rubber-like plastics and their physical testing) in Physical Chemistry of Polymers; a Lecturer (science graduate prepared to teach polymer chemistry and to work on colloid dispersions) in Polymer Chemistry; and a Lecturer (qualified young engineer prepared to treat rubber as an engineering material, particularly in dynamic applications) in Rubber in Engineering—The Clerk to the Governors, National College of Rubber Technology, Holloway, London, N.7.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences. No. 979, Vol. 250 (12 December, 1957): An Experimental Determination of the Fermi Surface in Copper. By A. B. Pippard. Pp. 325–357. 10s. 6d. No. 980, Vol. 250 (12 December, 1957): The Angular Acceleration of Liquid Helium II. By H. E. Hall. Pp. 359–385. 10s. (London: Royal Society, 1957.) [1612

Polish Cultural Institute. Selective Quarterly Guide to Polish Periodical Literature, Vol. II, 4, 1957. Pp. 1+74. (London: Polish Cultural Institute, 1957.) [1612

Ministry of Education. Report on the Regional European Seminar on The Universities and Adult Education, Bangor, North Wales, September 1st–14th, 1956. (Arranged by the United Kingdom National Commission for UNESCO.) Pp. xii+155. (London: H.M. Stationery Office, 1957.) 5s. net. [1712

Milford Haven Conservancy Bill. Pp. iv+38. (London: H.M. Stationery Office, 1957.) 1s. 9d. net. [1721

The Boards of the Nationalized Industries. By Lord Simon of Wythenshawe. Pp. 54. (London: Longmans, Green and Co., Ltd., 1957.) 2s. 6d. net. [2012

Other Countries

Food and Agriculture Organization of the United Nations. FAO Report No. 680: Report to the Government of India on Soil Conservation. By R. M. Gorrie. Pp. ii+15. (Rome: Food and Agriculture Organization of the United Nations, 1957.) [1612

Fifth Annual Report of the West African Institute for Oil Palm Research, 1956–57. Pp. 132. (Benin City: West African Institute for Oil Palm Research; London: Crown Agents for Oversea Governments and Administrations, 1957.) 2s. 6d. [1612

Institut des Parcs Nationaux du Congo Belge. Exploration du Parc National Albert (Mission J. de Heinzelin de Braucourt, 1950). Fascicule 3: Mollusques Quaternaires de la Region du Lac Edouard. By William Adam. Pp. 172+11 planches. Exploration du Parc National Albert. Deuxième Serie. Fascicule 4: Coagulation du Sang Chez les Arthropodes. Par Charles Grégoire et Pierre Jolivet. Pp. 45+9 planches. Exploration du Parc National de la Garamba (Mission H. de Saeger, en collaboration avec P. Baert, G. Demoulin, L. Denisoff, J. Martin, M. Micha, A. Noirfalise, P. Schoemaker, G. Troupin et J. Verschuren). Fascicule 8: Nematodes—Parasites d'Oiseaux. Par Claire Vuylsteke. Pp. 20. (Bruxelles: Institut des Parcs Nationaux du Congo Belge, 1957.) [1612

Report of the South African Museum for the year ended 31st March, 1957. Pp. 21. (Cape Town: South African Museum, 1957.) [1612

Berichte des Deutschen Wetterdienstes, Nr. 29 (Band 5): Tafeln zur Häufigkeitszerlegung mit Anwendungsbeispielen. Von Oskar Essenwanger. Pp. 13 mit 2 Abbildungen und 5 Tabellen im Text sowie 3 Tafeln. (Bad Kissinger: Deutschen Wetterdienstes, 1957.) [1612

Abridged Scientific Publications from the Kodak Research Laboratories, Vol. 33, 1951. Pp. 591+xxix. (Rochester, N.Y.: Eastman Kodak Company, 1957.) 3 dollars. [1612

An Annotated Checklist of the Birds of Borneo. By B. E. Smythies (*The Sarawak Museum Journal*, Vol. 7, No. 9, June, 1957.) Pp. xv+523–818. (Kuching, Sarawak: Sarawak Museum, 1957.) [1612

Wissenschaftliche Ergebnisse der Deutschen Atlantischen Expedition auf dem Forschungs-und Vermessungschiff "Meteor," 1925–1927. Band 9: Die Verteilung des Sauerstoffs und des Phosphats im Atlantischen Ozean. Zweite lieferung: Die Verteilung des Phosphats im Atlantischen Ozean. Von Hermann Wattenberg. Pp. 133–180+Tafel 1–26. (Berlin: Walter de Gruyter und Co., 1957.) [1612

Bulletin of the Astronomical Institutes of the Netherlands. No. 478 (1957 September 9): Photo-Electric Observations of the Polarization and Surface Brightness of the Crab Nebula made at the Observatoire de Haute Provence. By Th. Walraven. Pp. 293–316. No. 479 (1957 October 11): U Trianguli Australis, a Classical Cepheid with Secondary Period. By P. Th. Oosterhoff. Pp. 317–339. No. 480 (1957 November 9): Rotation and Density Distribution of the Andromeda Nebula Derived from Observations of the 21-cm. Line. By H. C. van de Hulst, E. Raimond and H. van Woerden. Pp. 1–20. No. 491 (1957 November 11): The Helium Spectrum of the Chromosphere. By C. de Jager and B. H. M. de Groot. Pp. 21–28. Annalen van de Sterrewacht te Leiden. Deel 20, Zeventiende Stuk: A Further Investigation of the Region Around CPD–31° 5547. Discussion of Fifteen Short-Period Variable Stars. Discussion of Ninety-Five Long-Period Variable Stars. By J. Ponsen. Pp. 1+421–465. (Leiden: Astronomical Institutes of the Netherlands, 1957.) [1612

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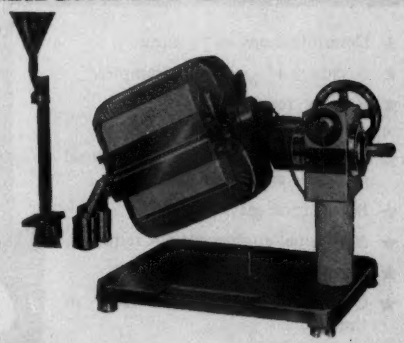

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